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JOURNAL OF PALEONTOLOGY

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VOLUME 26 JANUARY, 1952 NUMBER 1

THE TRILOBITE FAMILY DIONIDIDAE

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ABSTRACT—Examination of topotype specimens of *Dionide formosa* shows that the cephalon has a broad, bilaminar, pitted fringe similar to that of Cryptolithidae, but with the girder external. This fringe had not been stated to be present by previous writers on this group, and accordingly species of dionidids were restudied as far as possible. Four genera are recognized, *Dionide*, *Trinucleoides*, *Dionidella* and *Digrypos*, but knowledge of the latter two is inadequate. The family is represented by species ranging in age from Lower to Upper Ordovician, from eastern North America, Western Europe, and southeastern Asia. The Dionididae is placed with the Cryptolithidae, Raphiophoridae, Endymionidae, and Selenecemidae nom. nov. in the superfamily Cryptolithidea. It is shown that *Alsataspis* is a subjective synonym of *Seleneceme*, and the new name Selenecemidae is proposed to replace Alsataspidae.

INTRODUCTION AND ACKNOWLEDGMENTS

A REVISION of the genera that have been placed in the family Dionididae was undertaken in preparation for a contribution to the Treatise on Invertebrate Paleontology. An examination was first made of topotype specimens of the type species of *Dionide*, *D. formosa*. These are preserved as internal molds in dark grey argillaceous sediments. Two types of molds were observed (pl. 1, figs. 1, 2). As explained below, these are interpreted as showing that the cephalon of *Dionide* possessed a broad, bilaminar, pitted fringe, similar to that of the Cryptolithidae (throughout this paper the family name Cryptolithidae is used, rather than Trinucleidae, owing to the present uncertainty regarding the status of the name *Trinucleus*) but with the girder external. The nature of the cephalic border of *Dionide* has not been recognized previously, although references to the pits have been made. Dionidid material from Europe and America has been re-examined, and the evidence for the presence of the fringe observed in several species. I have not seen specimens of the type species of two recently erected genera, *Digrypos* and *Dionidella*. *Trigrypos* is shown to be most probably a synonym of *Dionide*. Dionidids are not common fossils, but are widespread in the world in Ordovician rocks. The systematic relationships of the Dionididae have also been investigated and the family is placed in the superfamily Cryptolithidea, together with the Cryptolithidae, Raphiophoridae, Endymionidae, and Selenecemidae nom. nov.

At the University of Birmingham, England, material from the following institutions was loaned to me for study (initials in brackets are those used subsequently in referring to particular specimens); Sedgwick Museum, Cambridge (SM), through the kindness of Mr. A. G. Brighton; British Museum (Natural History) (BM), courtesy of Mr. R. Baker; Geological Survey & Mu-

seum (GSM), through the kindness of Dr. C. J. Stubblefield. At a later stage, Dr. G. Arthur Cooper made available American dionidid material in the U. S. National Museum (USNM). In addition, the American and Bohemian specimens in the Museum of Comparative Zoölogy (MCZ) have been studied. I am indebted to the Research Committee, University of Birmingham, and the Harvard Foundation for Advanced Study & Research, for grants in aid of my work.

TERMINOLOGY

The terminology used herein is the same as that employed in a recent paper (Whittington, 1950b, p. 533). Additional terms that have been used in the description of the fringe of Cryptolithidae and Harpidae (Whittington, 1950a, pp. 2–3) are applied to the Dionididae, and text-figure 1 indicates their use. The term "preglabellar field" has been used by some authors to describe the entire area of the cephalon in front of the glabella, including the fringe and bounded by the projection of the axial furrows. This area is here referred to as the "preglabellar area." The term preglabellar field is applied to the area, if present, between the preglabellar furrow and the inner margin of the fringe, and bounded laterally by the projection of the axial furrows. *Dionide turnbulli* n. sp. (pl. 2, figs. 2, 3) possesses this area, and it is seen to be continuous with the inner anterior corners of the cheek lobes.

SYSTEMATIC PALEONTOLOGY

Superfamily CRYPTOLITHIDEA Richter, 1932
Family DIONIDIDAE Gürich, 1907; emend. Raymond, 1920

Trilobita with cephalon, thorax and pygidium subequal in length (sag.), cephalon subsemicircular in outline, genal spines long, pygidium subsemicircular or subtriangular in outline, smaller than, or subequal in size to, the cephalon. Glabella narrowest across the occipital ring, subquadrate or clavate in outline, the anterior part strongly convex, suboval lateral lobes situated just in front of the occipital furrow, median tubercle or short spine. Eyes absent, facial suture marginal, curving across the genal angle on the dorsal side. Cheeks and preglabellar area with broad bilaminar fringe, the two lamellae close together and with irregularly spaced opposing pits, largest externally; girder external, continuous with genal spines. Cheek crossed by one or more ridges (genal caeca) running from the axial furrow just in front of the lateral glabellar lobe to the genal angle. Hypostome with ovate middle body and broad (tr.) lateral areas.

Thorax of six segments, the first longer (sag. and exs.) than any succeeding. Axial ring in *Dionide* with anterior lateral corner isolated by a diagonal furrow; pleural furrow commencing at the inner anterior corner and running out in a curve concave forwards. Pygidium with narrow axis reaching almost to the posterior border and many ring and pleural furrows; in *Dionide* median portion of ring furrow running in a curve convex forwards, giving the characteristic outline to the axial ring.

Geological range and distribution.—Lower (Llanvirn) to Upper Ordovician of western Europe, eastern North America and southeastern Asia.

Discussion.—Raymond (1920, p. 274) is usually quoted as the author of this family, but Gürich (1907; 1908, p. 63) first proposed the name "Dionideae" for a subfamily of the Cryptolithidae (Trinucleidae) to include the genus *Dionide*.

The resemblances between Dionididae, Raphiophoridae (Whittington, 1950b, pp. 552–559) and Cryptolithidae (Whittington, 1941) have frequently been commented upon. The latter two are placed in the subfamily Cryptolithidea (Richter, 1932, p. 854; Stubblefield, 1936, p. 436), and I consider that the Dionididae should also be placed here. The general form of the cephalon, with forwardly expanding glabella, eyes absent, marginal suture, long genal spines is common to all. Dionidids and cryptolithids have a bilaminar fringe. In raphiophorids the doublure is rolled at the border of the cephalon, a structure recalling the external girder of dionidids. The long (sag. and exs.) first thoracic segment in dionidids is a feature shared with certain raphiophorids—*Raphiophorus*, *Ampyxina* and *Raymondella*. Members of all three families have five or six segments in the thorax and these segments have many characters in common. The anterolateral lobes of the axial rings in

Dionide appear to be peculiar to that genus. The pygidium of *Dionide* is likewise characteristic, with a narrow border and broad doublure (pl. 2, fig. 7). The pygidium of raphiophorids, cryptolithids and *Trinucleoides* has a narrow doublure and broad, steep border.

The genal caeca appear to be a characteristic feature of dionidids, consisting of one or two main ridges which run from a point in the axial furrow diagonally out to the genal angle. In *Dionide turnbulli* n. sp. the remainder of the cheek lobe is smooth. In *D. formosa* (pl. 1, figs. 1, 2, 5), *D. contrita* (pl. 1, figs. 3, 4) and other species the cheek lobe is ornamented by a raised network of ridges with pits between. These ridges appear sometimes to branch from the genal caeca, as in *D. contrita*, and form a radiating, anastomosing pattern. In *D. contrita* they reach the inner margin of the fringe, become fainter, and die out on the upper lamella. In *D. turnbulli* the cheek lobes are smooth, apart from the genal caeca, yet radiating

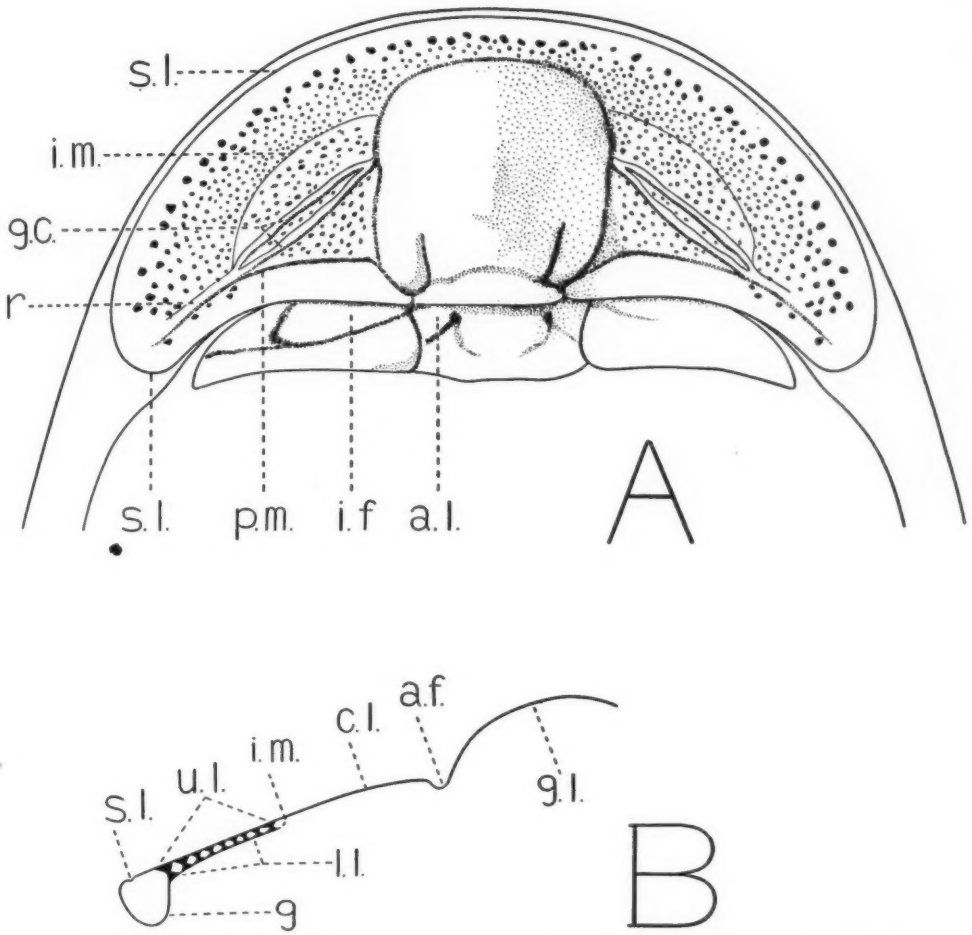

FIG. 1—*Dionide formosa* (Barrande). *1A*, Dorsal view of the cephalon and first thoracic segment drawn from BM In 42057, 42058 (pl. 1, figs. 1, 2), ×6. *1B*, Diagrammatic transverse cross-section through half of the exoskeleton of the cephalon, showing the structure of the fringe. s.l. = suture line; i.m. = internal margin of fringe; u.l. = upper lamella of fringe; l.l. = lower lamella of fringe; g = girder; c.l. = cheek lobe; g.c. = genal caeca; r = ridge on upper lamella continuous with genal caeca; p.m. = posterior marginal furrow; a.f. = axial furrow; g.l. = glabella; i.f. = inflated inner part of anterior pleural band of first segment; al = anterolateral lobe of axial ring. (p. 6)

ridges separate the pits in the fringe (pl. 2, figs. 3, 4, 6). This pattern of ridges on cheek lobes and fringe is like that seen in members of the families Harpidae and Harpididae (Whittington, 1950a, pp. 16–18), and other groups, but the pattern is not seen in members of other families regarded here as allied to the Dionididae.

A relationship with the Dionididae and/or the Raphiophoridae has also been suggested in the case of the following two families:

Family SELENECEMIDAE nom. nov.
(ALSATASPIDAE Turner, 1940)

Clark (1924, pp. 89–91, pl. 9, fig. 10; this paper, pl. 2, fig. 13) erected the genus *Seleneceme*, type species *S. propinqua* Clark, 1924. Only one incomplete specimen of the cephalon is known, from the Lower Ordovician *Shumardia* limestone at Lévis, Quebec. Clark did not describe the median glabellar furrow which, commencing at the anterior margin, extends back to half the length. The occipital ring is narrow (tr.) and short (sag.). A pair of longitudinal furrows run forward and slightly outwards from the occipital furrow and die out before reaching the midlength of the glabella. The cheeks slope gently outwards and downwards, and eyes are absent. The preglabellar field is continuous with the cheeks and slopes gently forwards, except for a narrow (transversally, the width about one-third the maximum glabellar width), anterior area, which is gently convex, most strongly so at the broken anterior margin of the specimen. The posterior border is much longer (exs.) than the occipital ring (sag.), so that the posterior marginal furrow commences at the axial furrow, in front of the point where the occipital furrow meets the axial furrow, and curves gently outwards and backwards.

If Clark's species (pl. 2, fig. 13) is compared with published figures of *Alsataspis bakeri* Turner, 1940 and *A. evansi* Kindle, 1942, it will be seen that all three have the glabella of circular outline, anterior median furrow, short, narrow occipital ring, the cheeks continuous with a broad preglabellar field (the anterior inflated area of the preglabellar field of *Seleneceme propinqua* corresponds to the base of the frontal spine of *A. bakeri* and *A. evansi*), and the characteristic curving posterior marginal furrow. It appears to me that *Alsataspis* is a subjective synonym of *Seleneceme*. All three species of *Seleneceme* occur in association with Lower Ordovician graptolite faunas (cf. Kindle, 1942). Turner (1940) proposed the family name Alsataspidae, and this should now be replaced with Selenecemidae nom. nov. Turner also suggested that the Selenecemidae may be related to the Dionididae and Raphiophoridae. The form of the cephalon, with the frontal spine and long genal spines, and the course of the facial sutures, resembles the Raphiophoridae, whereas the glabella with the short (sag.) narrow (tr.) occipital ring and subcircular outline, and the forward curve of the posterior marginal furrow, recall *Dionide*. *Seleneceme* has some 30 segments in the thorax, far more than in any genus of the superfamily Cryptolithidea known to me. Despite the distinctive nature of the thorax and pygidium, I consider that the Selenecemidae should be placed within the Cryptolithidea.

Family ENDYMIONIDAE Raymond, 1920

In this family have been included the genera *Endymionia* Billings, 1865, *Anisonotella* Whittington nom. nov., type species *Shumardia glacialis* Billings, 1865, original designation by Raymond, 1920, p. 277 (to

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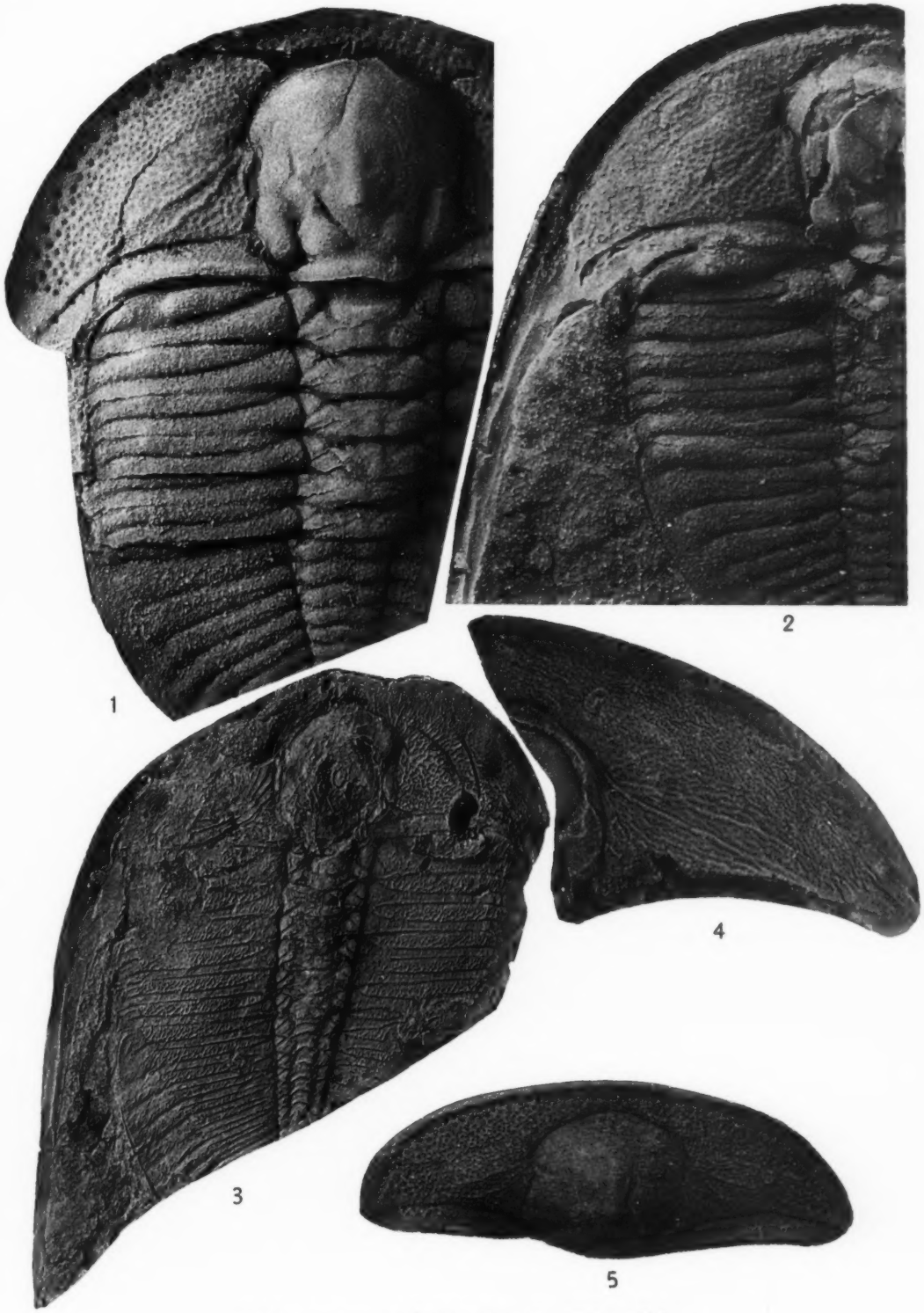
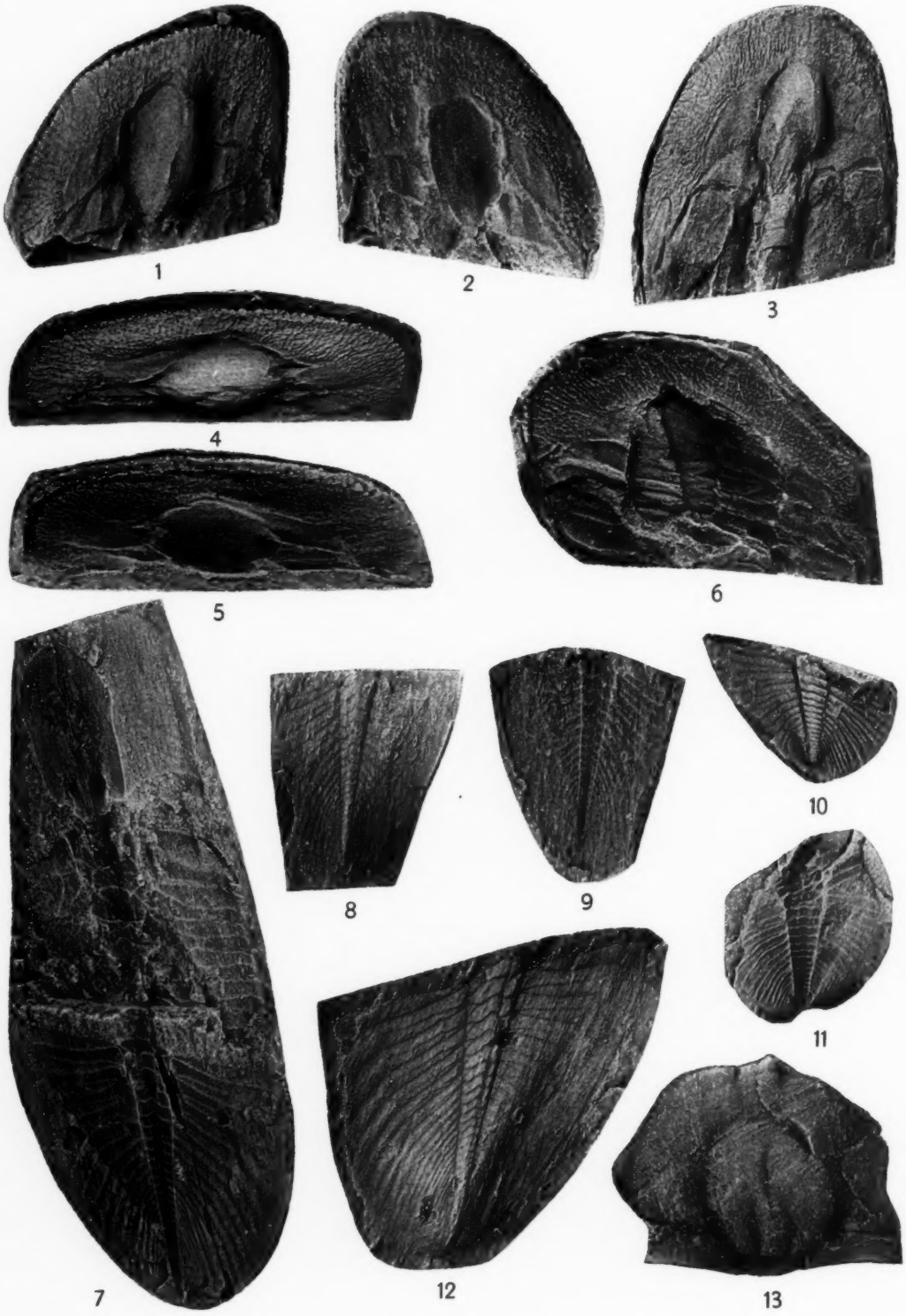
EXPLANATION OF PLATE 1

FIGS. *1, 2, 5—Dionide formosa* (Barrande). *1*, internal mold, cranidium with upper lamella of fringe bounded by suture line, ×6. Zahořany Beds, d_ϵ, Winice, Bohemia, Barrande Coll. BM. In 42057. *2*, internal mold, cephalon with upper lamella of fringe missing, lower lamella with girder and genal spine preserved, ×6. Zahořany Beds, d_ϵ, Winice, Bohemia, Barrande Coll. BM. In 42058. *5*, internal mold of cranidium, ×3. Zahořany Beds, d_ϵ Winice, Bohemia, Barrande Coll., BM. In 42062. (p. 6)

3, 4—Dionide contrita Raymond. *3*, internal mold, margin of cephalon incomplete around upper lamella on right side, ×3. Athens formation, ½ mile south of Lusters Gate, Virginia, USNM 72168. *4*, internal mold of incomplete cranidium bounded by suture line, ×6. Formation and locality as fig. *3*, USNM 72168. (p. 9)



Whittington, trilobite family Dionididae



Whittington, trilobite family Dionididae

replace *Anisonotus* Raymond, 1920; non *Anisonotus* White, 1847, nomen nudum; non *Anisonotus* Milne Edwards, 1879, p. 195), *Salteria* Thomson, 1864. *Pseudosalteria* Raymond, 1924, *Ampyxina* Ulrich, 1922, and *Seleneceme* Clark, 1924. I have recently (1950b, p. 557) placed *Ampyxina* in the Raphiophoridae, and *Seleneceme* is considered above to be the representative of a separate family. *Pseudosalteria* was founded upon a single specimen (Raymond, 1924, pp. 398–399, pl. 12, fig. 11). Professor Alan B. Shaw informs me (personal communication) that it is from the Gorge formation of Upper Cambrian (Trempealeauian) age, and that in his opinion it is of a young stage and therefore cannot be placed in a species or genus until more material is available. Clark (1924, p. 89) also records the genus "*Lekanaspis* Raymond," but this appears to be a nomen nudum.

The three genera remaining have a general resemblance to members of the Raphiophoridae, as Raymond pointed out, and it seems reasonable to place the Endymionidae within the Cryptolithidea.

Genus DIONIDE Barrande, 1847

Dione BARRANDE, 1846, non *Dione* Hübner, 1819.
Polytomurus HAWLE & CORDA, 1847.
Trigrypos KOBAYASHI, 1940.

Type species.—by monotypy, *Dione formosa* Barrande, 1846.

Geological range and distribution.—The species listed below appear to belong to this genus. As in a recent paper (Whittington, 1950b, p. 547, etc.) a position for the base of the Middle Ordovician has been arbitrarily selected, at the base of the zone of *Nemagraptus gracilis*.

Dionide prima KLOUČECK, 1917. Lower Ordovician (Llanvirn) of Bohemia.
Dionide rotundata WHITTARD, 1940. Lower Ordovician (lower Llanvirn) of England.
Dionide jubata RAYMOND, 1925. Lower Ordovician (Llandeilo, Svatá Dobrotivá shales, dy_{2b}) of Bohemia.
Dionide formosa BARRANDE, 1846. Middle Ordovician of Bohemia.
Dionide speciosus HAWLE & CORDA, 1847. Upper Ordovician of Bohemia.
Dionide euglypta var. *quadrata* WHITTARD, 1940. Middle Ordovician (*Dicranograptus clingani* zone) of England.
Dionide atra Salter, 1866. Middle Ordovician of North Wales.
Dionide contrita RAYMOND, 1920. Middle Ordovician, Virginia, U.S.A.
Dionide euglypta ANGELIN, 1854. Upper Ordovician of Norway and Sweden.
Dionide richardsoni REED, 1903. Upper Ordovician of Scotland.
Dionide asiatica KOBAYASHI, 1940 (*D. formosa* of Mansuy, 1912). Ordovician of Yunnan.

Certain of these species are discussed below. *Dionide želízkoi* Kobayashi, 1940 (a name proposed for the specimen figured by Želízko, 1906, pl. 1, fig. 7), from the Llanvirn of Bohemia, is not included, since the relationship of this incomplete specimen to other Llanvirn dionidid species in Bohemia is unknown. I have examined the type specimens of "*Dionide*" *lapworthi* Nicholson and Etheridge, 1880 (see also Reed, 1903, pp. 25–26, pl. 4, figs. 1, 2), and am uncertain whether or not this species belongs within the Dionididae. I could not find evidence for the presence of the lower lamella of the

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EXPLANATION OF PLATE 2

FIGS. *1–6, 10, 11—Dionide turnbulli* Whittington, n. sp. *1, 2*, holotype, counterpart molds, original of Reed, 1912, pl. 11, figs. 4, 4a, 4b, ×4½. Lower Llanvirn, Long Plantation Cutting, near Scolton, Haverfordwest, South Wales, SM A 16715 a, b. *3*, internal mold, original of Reed, 1912, pl. 11, figs. 3, 3a, ×4½. Horizon and locality as fig. *1*, SM A 16714. *4, 5*, counterpart molds, internal mold (fig. *4*) original of Reed, 1912, pl. 11, fig. 5, ×4½. Horizon and locality as fig. *1*, SM A 16716 a, b. *6*, external mold, original of part of Reed, 1912, pl. 11, fig. 2, ×4½. Horizon and locality as fig. *1*, SM A 16713a. *10*, internal mold, original of Reed, 1912, pl. 11, fig. 2a, ×3. Horizon and locality as fig. *1*, SM A 16712b. *11*, external mold, original of part of Reed, 1912, pl. 11, fig. 2, ×3. Horizon and locality as fig. *1*, SM A 16713 b. (p. 8)

7–9, 12—Dionide atra Salter. *7*, external mold, F. Ash Coll., ×2. Ty-obry beds, east of Portmadoc, Caernarvonshire, GSM (Geological Society Collection) 6976. *8*, internal mold, counterpart of original of fig. *9*, ×2. Horizon and locality as fig. *7*, GSM 35283. *9*, external mold, original of Reed, 1912, pl. 11, fig. 1, ×2. Horizon and locality as fig. 7, SM A 16747. *12*, lectotype, internal mold, probably original of Salter, 1866, pl. 11a, fig. 9, ×2. Horizon and locality as fig. *7*, GSM 35282. (p. 7)

13—Seleneceme propinqua Clark. Holotype, original of Clark, 1924, pl. 9, fig. 10, ×6. *Shumardia* limestone. Lévis formation, Lévis, Quebec, MCZ 1717. (p. 4)

fringe, and the pygidium is different from that of known dionidids.

In addition to those described in the following pages, I have examined material of *Dionide jubata*, *D. speciosus*, and *D. richardsoni*, all preserved as molds, and showing the same evidence for the presence of the bilaminar cephalic fringe as that described in *D. formosa*.

It will be noted that the generic names *Dionide* Barrande and *Polytomurus* Hawle and Corda are both dated 1847. It has proved impossible to establish the exact date of publication of either name. An appeal is being made to the International Commission on Zoological Nomenclature to suppress the name *Polytomurus* and place *Dionide* on the Official List of Generic Names.

DIONIDE FORMOSA (Barrande, 1846)
Plate 1, figures 1, 2, 5; text-figure 1

BARRANDE, J., 1846, pp. 32–33.
BARRANDE, J., 1852, pp. 640–642 (pars), pl. 42, figs. 24, 28; non figs. 25, 26, 27.
RAYMOND, P. E., 1925, pp. 22–23.

Discussion.—Barrande (1852, pp. 640–641) described *Dionide formosa* as having a fringe analogous to that of the Cryptolithidae, but rudimentary and not distinctly set off from the rest of the cheeks. The doublure of the cephalon was said to be narrow. Examination of topotype specimens (pl. 1, figs. 1, 2, 5) suggests that this description is not entirely correct. Internal molds, in which the doublure and genal spines of the cephalon are missing, show the characteristic outline of the cranidium, with rounded genal angles, this marginal outline being determined by the suture (pl. 1, figs. 1, 5). Inside the suture-line is a narrow, smooth area, and within that an irregular row of large, deep pits. Within this row the pits become shallower, smaller, and more closely spaced, and the pitting extends over the entire cheek area, but not on to the posterior border. A distinct line is seen (i.m. in text-fig. 1A), commencing at the anterolateral corner of the glabella and curving round parallel to the sutural margin, to reach the anterior edge of the posterior border. A third internal mold (pl. 1, fig. 2) is of a specimen in which the doublure of the cephalon and the genal spines were present. A distinct line is again seen, running from the anterolateral corner of the glabella to the anterior edge of the posterior border, in the same position as that on the previously described specimens (pl. 1, figs. 1, 5). Inside this line the mold of the cheek lobe is identical in the three specimens showing the pits and the genal caeca. Outside the line the appearance is quite different (pl. 1, fig. 2), showing an area which has indistinct closely spaced raised mounds, and outside this area a deep channel, continuous with the genal spine. I consider that this portion is the mold of the outer surface of the doublure of the cephalon, the deep channel being the mold of a ridge (in ventral aspect), the girder (g in text-fig 1B), the mounds being the in-fillings of pits (in ventral aspect) in the doublure. The inner margin of the doublure is at the line referred to above (i.m. in text-fig. 1). If this interpretation be correct, then the cephalon of *D. formosa* was characterized by having a broad bilaminar fringe (anteriorly extending in to the preglabellar furrow), the outer surfaces of the two lamellae being pitted, the pits apparently corresponding, and externally a prominent girder on the lower lamella, with a corresponding smooth area externally on the upper lamella. The suture traversed the margin of the fringe, curving across the dorsal surface at the genal angle. Thus the genal spines and lower lamella formed one structure, separated from the rest of the cephalon by the marginal suture. The hypostome was presumably attached to the inner edge of the doublure anteriorly. The cephalic fringe in dionidids is therefore similar to that in cryptolithids, but the girder in the former is external and the shallowness of the pits suggests that the two lamellae may have lain close together. This is suggested in text-fig. 1B.

The remainder of the exoskeleton of *Dionide formosa* was fully described by Barrande, and only the following additional comments are made:

a) The genal caeca (g.c. in text-fig. 1A) commence at the axial furrow opposite a point about half the length of the glabella and curve across the cheek lobe to the inner posterior corner of the fringe, where they unite and are continued across the upper lamella of the fringe by a single ridge (r in text-fig. 1A), which dies out before reaching

the suture line. An identical structure is seen in *Trinucleoides* (Whittington, 1940, pp. 257–258, pl. 4, fig. 1).

b) One specimen (MCZ 2305) shows the pitted ornament of the thoracic pleurae, strongest on the anterior band, and faintly developed also on the posterior band. The prominent furrows in the pleural lobes of the pygidium are pleural furrows, only the first three or four rib furrows being faintly indicated (e.g. pl. 1, figs. 1, 2). The area in front of the first few pleural furrows is strongly ornamented, as shown by Barrande (1852, pl. 42, fig. 24), and not the posterior pleural band as Barrande states (p. 642). The posterior pleural band of the first two or three segments is faintly ornamented.

c) Prantl and Přibyl (1948, pp. 2, 5) drew attention to the longer (sag. and exs.) and "inflated" first segment of dionidids. The inflation of the inner part of the anterior pleural band is clearly shown in pl. 1, figs. 1, 2 (left side, i.f. in text-fig. 1A), 3 (right side).

Raymond restricted *Dionide formosa* by the recognition of *D. speciosus* (Hawle and Corda) from the Upper Ordovician. Prantl and Přibyl (1948, p. 4) do not mention *D. speciosus* and apparently include these specimens in *D. formosa*. Examination of material in the Museum of Comparative Zoölogy suggests to me that this Upper Ordovician species *D. speciosus* should be retained, the characteristic feature being the relatively shorter pygidium, of rounded outline, and with fewer rings in the axis. The specimens show a second tubercle on the glabella close behind the median one, but I do not think that it is the base of a spine, as Raymond claimed (1925, pp. 23, 25).

DIONIDE ATRA Salter, 1866
Plate 2, figures 7, 8, 9, 12

Dionide atra SALTER, 1866, pp. 321–322, pl. 11a, figs. 9, 9a.
Dionide atra REED, 1912, pl. 11, fig. 1, non figs. 2–6.
Trigrypos atra KOBAYASHI, 1940. (pars)

Lectotype (here selected).—GSM 35282, probably the original of Salter's pl. 11a, fig. 9, internal mold, from the Ty-obry Beds east of Portmadoc, Caernarvonshire. These beds are described by Fearnsides and Davies (1944, pp. 254–255), and the evidence of the age discussed by Stubblefield and Bulman (pp. 272–274). It is concluded that the age is probably Llandeilo-Caradoc, i.e. early Middle Ordovician.

Other material.—GSM 35283, SM A 16747 (figured Reed, 1912, pl. 11, fig. 1), counterpart molds of pygidium, and GSM (Geological Society collection) 6976, all from the same locality as the lectotype.

Discussion.—This species was based upon distorted specimens of the pygidium only, and one of them, GSM 10181, the original of Salter, 1866, pl. 11a, fig. 9a, cannot be traced. The pygidium may be described as follows:

Outline subsemicircular, the length (sag.) approximately equal to the maximum width. The axis is narrow, gently convex, reaching almost to the posterior margin, the posterior part narrow and raised; some 20 axial rings, the gently convex anterolateral parts marked off by faint diagonal furrows, the ring furrow curving forward to the midline to give the characteristic outline to the posterior margin of the ring. The inner part of the side lobe is gently convex, especially posteriorly, the outer part flattened or concave; rib furrows faint, only those of the first six segments visible, some 20 pleural furrows, progressively more strongly backwardly-directed posteriorly; at about half the width curving gently, becoming fainter and continuing out to near to the margin.

An additional specimen (pl. 2, fig. 7), showing part of the thorax and cephalon as well as the characteristic pygidium, was collected by F. Ash. It is an external mold, and distorted. The outline of the glabella, the forwardly directed basal glabellar furrows, the faint genal caeca, and the course of the posterior marginal furrow, convex forwards, are characteristic of *Dionide*. Three axial rings and five left pleurae can be seen, and the most anterior segment is markedly longer than the rest. The anterolateral lobes of the axial rings, outline of the pleurae with blunt, posteriorly-directed tips and course of the pleural furrow, concave forwards, are typical of *Dionide*.

The understanding of Salter's species has been confused since Reed (1912) included within it material from a different locality, Scolton, and of a different age. The Scolton material is here regarded as representing a

separate species, *Dionide turnbulli* sp. nov. Kobayashi (1940), using Reed's description (mainly based on the Scolton material) erected the genus *Trigrypos*, citing *D. atra* as type species. Kobayashi had a mistaken impression of the specific characters of *D. atra*, based on Reed's work, and his diagnosis is unrelated to specimens from Tyobry. As pointed out above, from the incomplete evidence available it seem probable that Salter's species belongs in the genus *Dionide*, and that therefore *Trigrypos* should be regarded as synonymous.

DIONIDE TURNBULLI Whittington, n. sp.
Plate 2, figures 1–6, 10, 11

Dionide atra REED, 1912 (pars, non Salter), pl. 11, figs. 2–6. non fig. 1.
Trigrypos atra KOBAYASHI, 1940 (pars).

Holotype.—SM 16715a and 16715b, counterpart molds, originals of Reed's pl. 11, figs. 4, 4a, 4b. Lower Llanvirn, Long Plantation Cutting, near Scolton, Haverfordwest district, Pembrokeshire, South Wales. The collections from this locality in the Sedgwick Museum, Cambridge, include the following: *Didymograptus bifidus*, *"Agnostus" morei*, *Ampyx salteri*, *Barrandia* sp., *Ectillaenus perovalis* forma *hughesi*, *Placoparia zippei*, *Cyclopyge binodosa*, *Trinucleus* sp. This assemblage is characteristic of the lower Llanvirn (*D. bifidus* zone) in the Anglo-Welsh area (cf. Stubblefield, 1939, pp. 53–54; Whittard, 1940), and the beds are not of Upper Llanvirn age, as stated by Williams (1948, p. 68).

Other material.—SM 16712–4, 16716, originals of Reed's figures 2, 2a, 3, 3a, 5, and from the same horizon and locality.

Description.—Complete exoskeleton not known. The cephalon is subsemicircular in outline, convex. The glabella is subquadrate in outline, convex, the anterior margin rounded, the sides subparallel, abruptly narrowing at the base, and the width (tr.) of the occipital ring is about two-thirds the maximum width at the midlength; the basal glabellar furrows run forwards and slightly inwards from the anterolateral corners of the occipital ring, and die out. SM 16714 and 16716a (pl. 2, figs. 3, 4 respectively) suggest that the furrows may run to the midline. Axial and preglabellar furrows continuous, shallow. The cheek lobe is a quarter-circle in outline, convex, sloping outwards and downwards, and the lobes are united in front of the glabella by the narrow (sag.) preglabellar field. The posterior border is not preserved, but the posterior marginal furrow is broad and shallow (pl. 2, fig. 3, right side). Eyes are absent, and the cheek lobe is crossed by a strong genal caecum, which, commencing at the axial furrow at about half the length of the glabella, runs in a curve convex outwards to the posterolateral corner, and on to the fringe. The fringe is narrowest (sag.) anteriorly, widest (tr.) laterally, sloping outwards and downwards, a deep girder externally, and prolonged a short distance beyond the rest of the cephalon. The fringe is crossed by radiating, anastomosing ridges, between which are lines of fine pits, and there is a single row of coarser pits just within the girder. Pl. 2, figs. 1, 3, 4, molds of the outer surface of the lower lamella, shows clearly the radiating ridges (preserved as grooves in the mold), the fine pits between and the coarse outer row. Pl. 2, figs. 2, 5, external molds of the outer surface of the upper lamella, show the ridges less distinctly, but the outer row of large pits is clear. Pl. 2, fig. 6, I interpret as an incomplete mold of the outer surface of the cephalon, to which is clinging a mold of the inner surface of the inner part of the lower lamella, so that, while the external row of large pits appear as mounds (in-fillings of pits in the upper lamella), the inner part of the fringe is covered by ridges (molds of grooves in the inner surface of the lower lamella). The two lamellae of the fringe are presumably separated by a marginal suture, as in the type species.

The hypostome is unknown.

Fragments only of the thorax are known in two specimens (pl. 2, figs. 3, 6). The pygidium is subsemicircular in outline, the axis prominent, extending close to the margin, some 18 rings, the ring furrow having the forward curve to the mid-line characteristic of *Dionide*. The inner parts of the side lobes are gently convex, especially close to the posterior part of the axis, the outer parts flattened. The first five rib furrows are faintly marked. Twelve or more pleural fur-

rows, curved gently back, directed more strongly back posteriorly, and reaching close to the margin.

Discussion.—Reed claimed that the glabella was "produced behind into [a] short blunt median spine" (1912, p. 200), but I do not consider that the specimens, especially SM A 16716 (pl. 2, figs. 4, 5), justify this interpretation. I have not been able to discern either the "ocular tubercle" on the genal caeca, or the "very minute punctae and extremely delicate striae present over [the] whole surface" of the cheek lobes and glabella. As Reed recognized, the radiating ridges of the fringe of *Dionide turnbulli* recall that of some harpids (see above).

The distortion of the specimens of *Dionide turnbulli* and *D. atra* make it difficult to discern any differences between the pygidia of the two species, and Reed regarded them as identical. We know little of the cephalon of *D. atra*. Until more material is forthcoming, I prefer to regard the Scolton and Tyobry material as representing two distinct species, especially in view of the difference in age.

Williams (1948, pp. 66–68, text-fig. 1) has pointed out that *Lloydolithus* (*Protolloydolithus*) *ramsayi* (Hicks, 1875), from the lower Llanvirn of Ramsey Island, Pembrokeshire, and the Llandeilo area, Carmarthenshire, is not identical with the material here called *Dionide turnbulli*, as Reed (1912, p. 202) stated it to be. Williams (1948, p. 68) has listed some important differences between *L.* (*P.*) *ramsayi* and *D. turnbulli*. Nos. 1 and 2 are here amended to read: In both species there is a broad, bilaminar fringe to the cephalon; in *L.* (*P.*) *ramsayi* there is a single row of large pits outside the girder, in *D. turnbulli* the girder is external, with a coarse row of pits immediately inside. In *L.* (*P.*) *ramsayi* the fringe is pitted along irregularly radial lines; in *D. turnbulli* the fringe is crossed by radiating, anastomosing ridges, with tiny pits between.

From the Bohemian Llanvirn species *Dionide jubata*, *D. turnbulli* is distinguished by the smooth cheek lobes, presence of the preglabellar field, the ridges on the fringe, and the greater number of segments in the pygidium. *D. rotundata*, from the Llanvirn of Shropshire, is known only from a cranidium. The presence of anastomosing ridges on the fixed cheeks recalls *D. turnbulli*, but the cheek lobes are not smooth.

Prantl and Přibyl (1948, pp. 2–6, pl. 1, fig. 1, text-fig. 4) have erected a new genus *Dionidella* based upon a Llanvirn species *D. incisa*. The structure of the fringe is not described, and it is difficult to compare the cephala of *D. incisa* and *D. turnbulli*. The glabella is somewhat similar in the two, but the inner part of the cheeks is pitted in *D. incisa*. The pygidium of the latter is composed of fewer segments, and bears a median marginal spine. Pending the description of additional material of *D. incisa*, it is impossible to decide whether or not *D. turnbulli* should be placed in *Dionidella*. I have placed *D. turnbulli* in *Dionide*, but the presence of the preglabellar field, combined with the strongly developed radiating ridges on the fringe, distinguish it at once from the type and other species.

DIONIDE CONTRITA Raymond, 1920
Plate 1, figures 3, 4

Discussion.—This species is to be redescribed in a paper by Professor Byron N. Cooper which will be published shortly. The specimens here figured show the dionidid characters clearly. The glabellar outline is characteristic. The position of the inner margin of the fringe is revealed in these internal molds of the dorsal surface of the cephalon by the line which, commencing at the preglabellar furrow, curves across the cheeks subparallel to the anterolateral margin. Inside this line is the cheek lobe, showing the genal caeca and a pattern of radiating, anastomosing ridges with pits between. Outside the line is a much more finely-pitted zone, the upper lamella of the fringe, and the radial ridges of the cheek lobes die out as they extend on to the fringe. Externally is a smooth band, overlying the girder, and immediately inside the girder are the coarsest pits in the fringe, irregularly spaced. The thorax and pygidium are typical, showing the anterolateral lobes of the axial rings, the pleural furrows running in a curve concave forwards, and the ornament on the anterior bands.

Professor Byron N. Cooper also informs me (personal communication) that the

specimen figured by Raymond (1925, pl. 1, fig. 16), and those figured by Cooper and Cooper (1946, pl. 3, figs. 9, 10), represent a species which does not belong within the Dionididae.

Genus DIONIDELLA Prantl and Přibyl, 1948

Type species: *Dionidella incisa* Prantl and Přibyl, 1948.

Discussion.—Until the fringe of the type species is described it will be impossible to discuss its relationship with other dionidid species, and particularly with those of about the same age. *Dionide turnbulli* has the preglabellar field (in the sense in which the term is used herein), but we do not know whether or not it is present in *Dionidella incisa*, for Prantl and Přibyl apparently use the term in a different sense. It is difficult to compare the glabella of *Dionidella incisa* with that of other species since in so many cases they are preserved in shales and crushed. The relatively elongated outline of the exoskeleton and the pygidial spine appear to be characters distinctive of *Dionidella incisa*.

Genus TRINUCLEOIDES Raymond, 1917

Type species: *Trinucleus reussi* Barrande, 1856.

Discussion.—The type and only known species is from the Šárka Beds, $d\gamma_1$ Llanvirn, at Osek, near Rokycany, West Bohemia, and was redescribed by me in 1940 (pp. 255–259, pl. 1, fig. 7, pl. 4, figs. 1–8). At that time I placed the genus with the Cryptolithidae (Trinucleidae), but in 1941 (p. 22) I excluded it from this family. More recently Prantl and Přibyl (1948, p. 5) have suggested that *Trinucleoides* may not be a dionidid, mainly because *T. reussi* does not have the longer (sag. and exs.) first thoracic segment characteristic of dionidids. However, the first segment in *T. reussi* is longer than any of the succeeding segments (Whittington, 1940, p. 258, pl. 4, figs. 4, 5). *Trinucleoides* has the following characters that ally it with *Dionide:*

1) The plan of the glabella, with lateral basal lobes, though these lobes are situated a short distance in front of the occipital furrow in *Trinucleoides*, in contrast to the situation in *Dionide.*

2) The bilaminar pitted fringe with external girder continuous with the genal spine (Whittington, 1940, p. 258, pl. 4, figs. 1, 2, 6).

3) The genal caeca on the cheek lobes which unite and run on to the upper lamella of the fringe at the genal angle as a ridge.

4) The outline and form of the hypostome.

5) The thorax of six segments; the first longest (sag. and exs.), the pleural furrows running out in a curve concave forwards from the inner, anterior corner.

The axial rings of *Trinucleoides* do not show the anterolateral lobes of *Dionide*, and the pygidium recalls that of cryptolithids or raphiophorids rather than that of *Dionide.* However, the characters listed above seem to me to outweigh the resemblances that *Trinucleoides* shows in certain respects to cryptolithids and raphiophorids, and I therefore place this genus in the Dionididae.

Genus DIGRYPOS Kobayashi, 1940

Type species: *Dionide hybrida* Reed, 1915.

Discussion.—The type species is founded on a single cephalon from the Middle Ordovician Hwe Maung beds of the Northern Shan States, Burma. The glabella is characteristically dionidid, and Reed's figure (1915, pl. 5, fig. 7) suggests the presence of the bilaminar pitted fringe with external girder and a row of coarse pits just within the girder. Posterolaterally the fringe narrows (tr.) and the pits do not extend to the genal angle. It seems clear that this species is a dionidid, and possibly the representative of a distinct genus, as Kobayashi claimed (1940, pp. 204, 207), but further material is needed before this claim can be soundly based.

REFERENCES

BARRANDE, J., 1846, Notice Préliminaire sur le Système Silurien et les Trilobites de Bohême. Leipsig.

——, 1847, Über das Hypostoma und Epistoma, zwei analoge, aber verschiedene Organe der Trilobiten: Neues Jahrb. f. Min., pp. 385–399.

——, 1852, Système Silurien du Centre de la Bohême. vol. I, Prague and Paris.

BULMAN, O. M. B., 1944, in discussion, Fearnsides and Davies, 1944, op. cit. below, p. 274.

CLARK, T. H., 1924, The paleontology of the Beekmantown series at Lévis, Quebec: Bull. Amer. Paleont., vol. 10, no. 41, pp. 1–134, pls. 1–9.

COOPER, B. N., and COOPER, G. A., 1946, Lower Middle Ordovician stratigraphy of the Shenan-

doah Valley, Virginia: Geol. Soc. America, Bull., vol. 57, pp. 35–114, pls. 1–3.

FEARNSIDES, W. G., and DAVIES, W., 1944, The Geology of Deudraeth. The country between Traeth Mawr and Traeth Bâch, Merioneth: Quart. Jour. Geol. Soc., London, vol. 99, pp. 247–272, pls. 23, 24.

GÜRICH, G., 1907, Versuch einer Neueinteilung der Trilobiten: Cbl. f. Min. Geol. Pal., pp. 129–133.

——, 1908, Leitfossilien, vol. I, Kambrium und Silur. Berlin.

HAWLE, I., and CORDA, A. J. C., 1847, Prodrom einer Monographie der böhmischen Trilobiten. Prague, pp. 1–176, pls. 1–7 (Abh. der k. Böhm. Gesell. der Wiss., vol. 5 for 1847, dated 1848, pp. 111–292, pls. 1–7).

HÜBNER, J., 1816–25, Verzeichniss bekannter Schmetterlinge. Augsburg.

KINDLE, C., 1942. *Alsataspis* in Newfoundland: Canadian Field-Nat., vol. 56, no. 3, p. 33.

KLOUČEK, C., 1917, Über die $d_1\gamma$-schichten und ihre Trilobitenfauna: Bull. Int. de l'Acad. des Sci. de Bohême, Résumes, vol. 21, 16 pages, one plate.

KOBAYASHI, T., 1940, Note on the Dionideidae: Japanese Jour. Geol. and Geog., vol. 17, pp. 203–208.

MANSUY, H., 1912, Étude Géologique du Yunnan Oriental: Mém. d. Serv. Géol. de l'Indochine, vol. 1, fasc. II, part 2, Paléontologie.

MILNE EDWARDS, A., 1879, Mission Scientifique au Mexique et dans l'Amérique centrale. Rech. zool., part 5, vol. 1, Études sur les xiphosures et les crustacés de la région Mexicaine. Paris, 1873–1880.

NICHOLSON, H. A., and ETHERIDGE, R., 1880, A monograph of the Silurian fossils of the Girvan District in Ayrshire. Fasc. III. Edinburgh and London.

PRANTL, F., and PŘIBYL, A., 1948, Some new or imperfectly known Ordovician trilobites from Bohemia: Bull. Int. de l'Acad. Tchèque des Sci., vol. 49, no. 8, pp. 1–23, pls. 1–3.

RAYMOND, P. E., 1920, Some new Ordovician trilobites: Bull. Mus. Comp. Zoöl., vol. 64, no. 2, pp. 273–296.

——, 1924, New Upper Cambrian and Lower Ordovician trilobites from Vermont: Proc. Boston Soc. Nat. Hist., vol. 37, pp. 389–466, pls. 12–14.

——; 1925, Some trilobites of the lower Middle Ordovician of eastern North America: Bull. Mus. Comp. Zoöl., vol. 67, no. 1, pp. 1–180, pls. 1–10.

REED, F. R. C., 1903–6, The Lower Palaeozoic trilobites of the Girvan District, Ayrshire: Mon. Palaeont. Soc. London, pp. 1–186, pls. 1–20.

——, 1912, *Dionide atra*, Salter: Geol. Mag., n.s., dec. 5, vol. 9, pp. 200–203, pl. 11.

——, 1915, Supplementary memoir on new Ordovician and Silurian fossils from the Northern Shan States: Mem. Geol. Surv. India, n.s., vol. 6, Mem. No. 1, pp. 1–98, pls. 1–12.

RICHTER, R., 1932, Crustacea (preprint) in Handwörterbuch der Naturwissenschaften, vol. 2, 2nd edition, 1933, Jena, pp. 840–863.

SALTER, J. W., in Ramsay, A. C., 1866, The geology of North Wales: Mem. Geol. Surv. Gt. Britain, vol. 3, pp. 1–381, pls. 1–28.

STUBBLEFIELD, C. J., 1936, Cephalic sutures and their bearing in current classifications of trilobites: Biol. Rev., Cambridge, vol. 11, pp. 407–440.

——, 1939, Some aspects of the distribution and migration of trilobites in the British Lower Palaeozoic faunas: Geol. Mag., vol. 76, pp. 49–72.

——, 1944, in discussion, Fearnsides and Davies, 1944, op. cit. pp. 272–273.

TURNER, F. E., 1940, *Alsataspis bakeri*, a new Lower Ordovician trilobite: Jour. Paleontology, vol. 14, pp. 516–518.

WHITE, A., 1847, List of the specimens of the Crustacea in the British Museum: British Museum, London.

WHITTARD, W. F., 1940, The Ordovician trilobite fauna of the Shelve-Corndon District, West Shropshire—Part II: Ann. Mag. Nat. Hist., ser. 11, vol. 6, pp. 129–153, pls. 4–7.

WHITTINGTON, H. B., 1940, On some Trinucleidae described by Joachim Barrande: Am. Jour. Sci., vol. 238, pp. 241–259, pls. 1–4.

——, 1941, The Trinucleidae—with special reference to North American genera and species: Jour. Paleontology, vol. 15, pp. 21–41, pls. 5, 6.

——, 1950a, A monograph of the British trilobites of the family Harpidae: Mon. Palaeont. Soc., London, pp. 1–55, pls. 1–7.

——, 1950b, Sixteen Ordovician genotype trilobites: Jour. Paleontology, vol. 24, pp. 531–565, pls. 68–75.

WILLIAMS, A., 1948, The Lower Ordovician cryptolithids of the Llandeilo District; Geol. Mag., vol. 85, pp. 65–88, pl. 6.

ŽELÍZKO, J. V., 1906, Geologisch-Palaeontologische Verhältnisse der nächsten Umgebung von Rožmitál in Böhmen: Bull. Int. de l'Acad. des Sci. de Bohême, Résumes, vol. 11, pp. 311–323, pls. 1, 2.

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LOWER PERMIAN AMMONOIDS FROM THE IRWIN BASIN, WESTERN AUSTRALIA

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ABSTRACT—Two new species of Permian ammonoids, *Metalegoceras campbelli* and *Uraloceras irwinense*, are described from the Irwin Basin, Western Australia. *Metalegoceras jacksoni* is redescribed and the genus *Metalegoceras* reviewed. The validity of *Uraloceras* is considered. A Sakmarian age is ascribed to the Irwin River ammonoid fauna.

INTRODUCTION

AMMONOIDS are rare in the Permian rocks of Australia. Up till now only eight species were known, and the recent find of two additional species is, therefore, of some interest. Permian rocks and their faunas in Australia represent two quite distinct paleogeographical provinces known as the Eastern Australian and the Western Australian Province (Teichert 1951). Only one ammonoid, *Adrianites meridionalis* Teichert and Fletcher (1943), has so far been described from the eastern province, whereas small ammonoid faunas are scattered throughout the western province and have been described from three of the four basins (fig. 1) which represent this province (Miller 1932, 1936; Teichert 1942, 1944).

The Irwin Basin is the most southerly marine Permian basin in Western Australia and from it came *Gastrioceras jacksoni* (Etheridge 1907), the first ammonoid to be described from this province.

SUCCESSION

The Permian sediments of the Irwin Basin outcrop over an area of approximately 200 square miles between 28° 30′ and 29° 30′ S. Lat. (fig. 2). They occur in a topographical basin bordered to the north, south and west by the Jurassic sediments and Recent sands of the Coastal Plain. The eastern margin is downfaulted against the Precambrian crystalline complex by the Darling Fault.

The succession (Clarke, Prendergast, Teichert, and Fairbridge 1950) is as follows:

7. *Wagina Sandstone:* Mottled red and white sandstones, with intercalations of conglomerate, quartz grit and shale; the latter contains plants but the rest is unfossiliferous. 300 feet+

6. *Carynginia Shale:* Rhythmically banded jarositic shales, passing up into fine banded sandy silts; locally with fossiliferous marine lenses and conglomeratic lenses and pockets of erratics near the base. 800 feet

5. *Irwin Coal Measures:* Sandstones and shales with lenticular coal seams and plant fossils. 160 feet

4. *High Cliff Sandstone:* White and red sandstones and conglomerates. 110 feet

3. *Fossil Cliff Formation:* Sandy siltstones, shales and mudstones, with lenticles of limestones. Rich in marine fossils. 180 feet

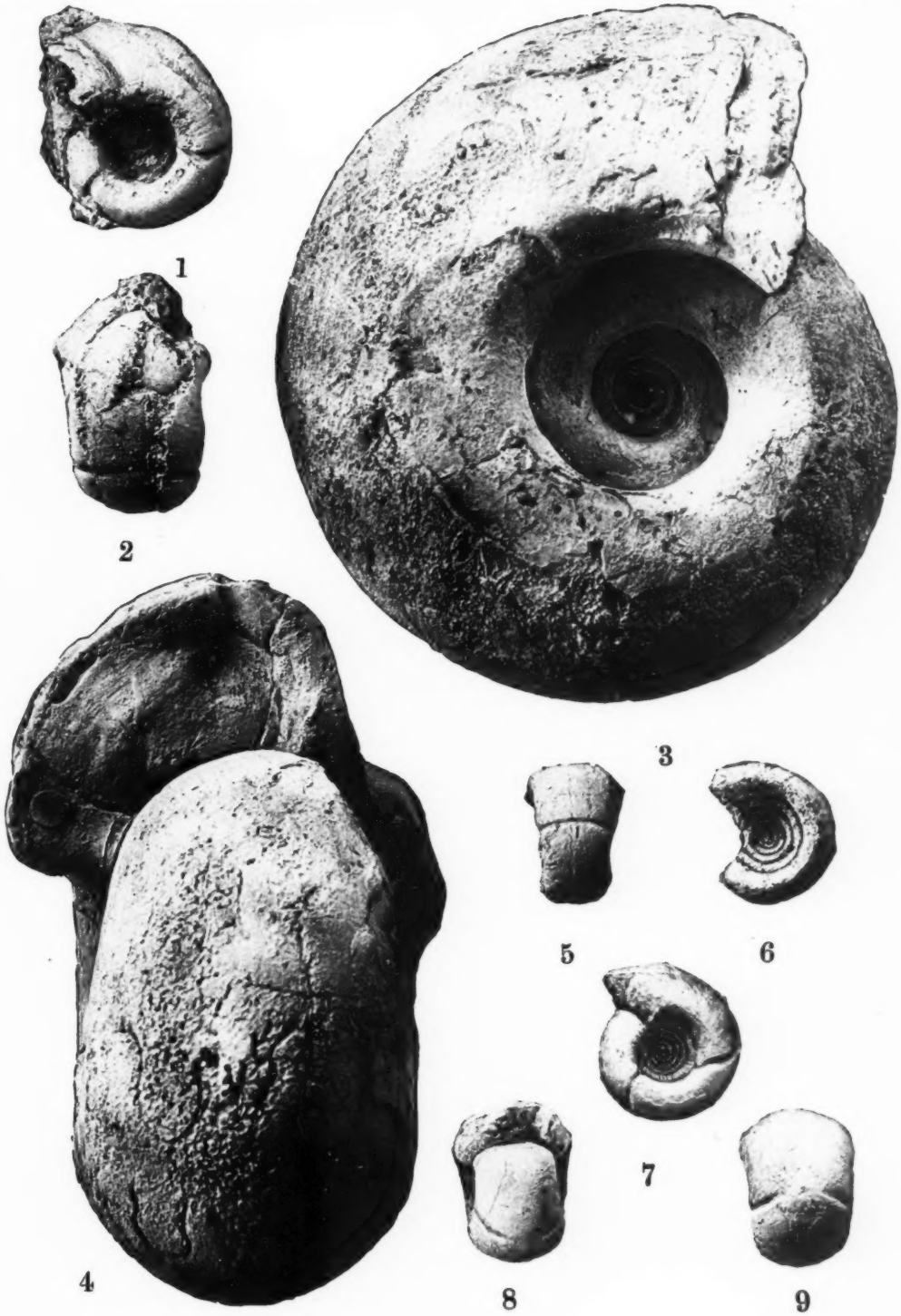
2. *Holmwood Shale:* Rhythmically banded shales and mudstones, with ferruginous and calcareous concretions (some septarian nodules), and increasing amounts of jarosite and gypsum towards the top. Infrequent thin bands of limestone and calcareous mudstone containing marine fossils, otherwise generally unfossiliferous except near the top. 1650 feet

1. *Nangetty Formation:* Tillites, glacial shales,

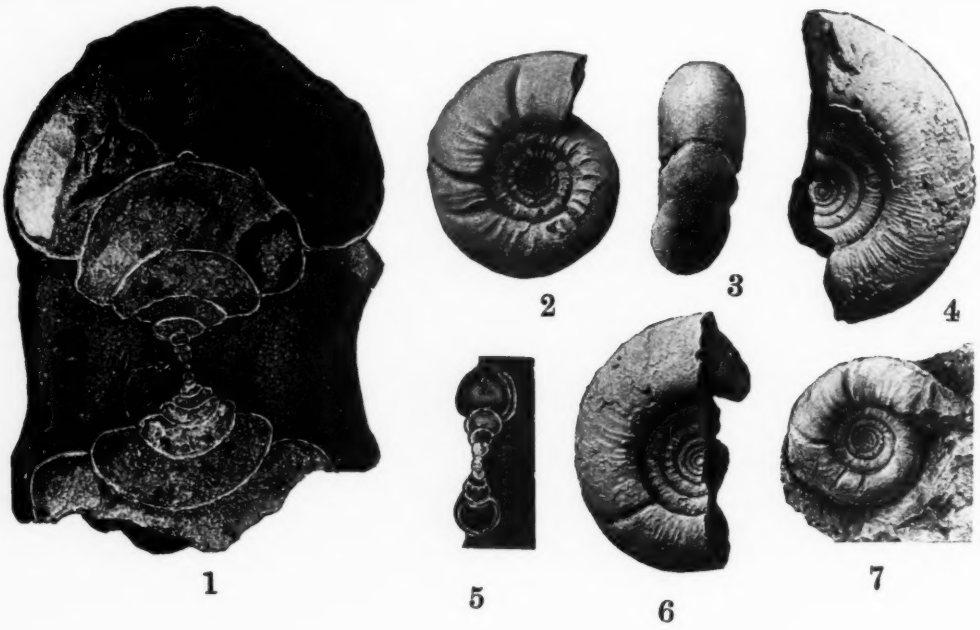
EXPLANATION OF PLATE 3

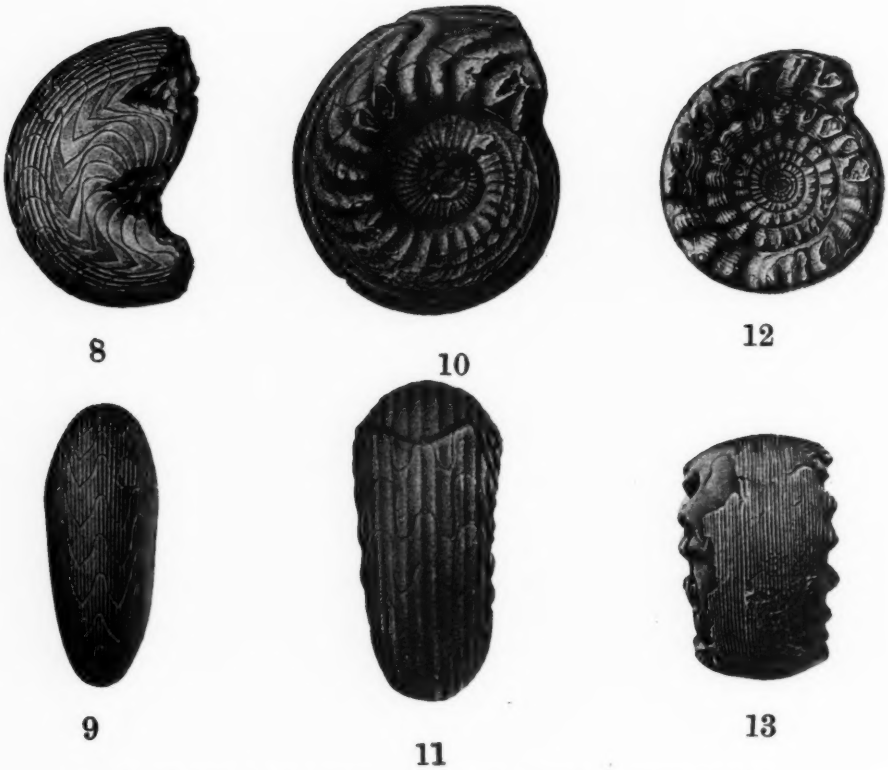
FIGS. *1–6*—*Metalegoceras jacksoni* (Etheridge). *1*, *2*, lateral and ventral views of hypotype (no. 32030a), ×2; *3*, *4*, lateral and ventral views of holotype (no. 11980), ×1; *5*, *6*, ventral and lateral views of hypotype (no. 32030b), ×3. (See also plate 4). (p. 16)

7–9—*Metalegoceras campbelli* Teichert and Glenister, n. sp., Lateral and ventral views of holotype (no. 1981), ×2. (p. 18)



Teichert and Glenister, Australian Permian ammonoids





Teichert and Glenister, Australian Permian ammonoids

fluvio-glacial sandstones, locally with calcareous grits and sandstones showing Fontainebleau structure, underlain by further glacial shales and basal conglomeratic grits.

800 feet (estimated)
Total thickness 4,000 feet

The whole sequence appears to be conformable. Its base is not exposed, but it is overlain by sandstones of Jurassic and possibly later age. The ammonoids described in this paper all come from the Holmwood

FIG. *1*—Map of Western Australia. The crosses indicate the occurrence of Permian ammonoid faunas.

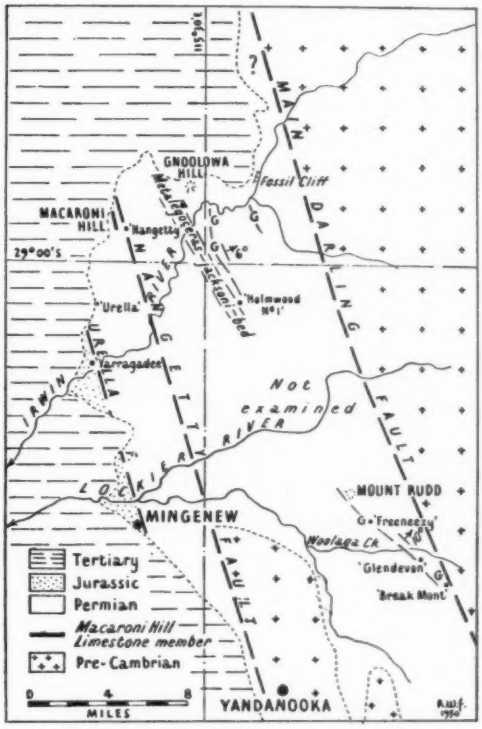


FIG. *2*—Geological map of the northern part of the Irwin Basin, Western Australia. G represents the outcrop of the bed containing *Metalegoceras campbelli* Teichert and Glenister, n. sp. and *Uraloceras irwinense* Teichert and Glenister, n. sp.

shale. The lower 950 feet of this formation are grey calcareous shales with many concretionary bands and are known as the lower Holmwood shale. Towards the top, the colour changes from grey to yellow or buff and siderite becomes an important constituent. Thin bands of grey crystalline limestone, 1–5 feet thick, generally developing cone-in-cone structure, are common in

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EXPLANATION OF PLATE 4

FIG. *1*—*Metalegoceras jacksoni* (Etheridge). Cross section of hypotype (no. 32030c), ×1½ (p. 16)
2–7—*Uraloceras irwinense* Teichert and Glenister, n. sp., *2*, *3*, lateral and ventral views of paratype (no. 32037), ×2; *4*, lateral view of a well-preserved fragment, ×3; *5*, cross section of paratype (no. 32039), ×1½; *6*, lateral view of paratype (no. 32038), ×3; *7*, lateral view of holotype (no. 32036), ×1. (p. 21)
8–9—*Pseudogastrioceras abichianum* (Möller). Ventral and lateral views of a syntype, after Abich, ×½. (p. 20)
10–11—*Altudoceras altudense* (Böse). Lateral and ventral views, ×2. (p. 21)
12–13—*Paragastrioceras jossae* (de Verneuil). Lateral and ventral views, ×¾. (p. 20)

the top 750 feet of the lower Holmwood shale. An olive brown calcareous mudstone found in a thin bed 20 feet below the top of this portion of the section abounds in specimens of *Metalegoceras jacksoni* with which orthoceroids and crinoid stems, both very rare, have been found associated. Although several separate outcrop lines containing this fauna were observed in the field, it is now considered that they represent a single bed repeated by strike faulting.

The upper Holmwood shale consists of 700 feet of olive-brown to grey shales which are generally unfossiliferous, with the exception of small pockets of fossils in shaly mudstones near the top. In addition there are lenticular masses of serpulid limestone near the base of the upper Holmwood shale and five or six bands of sandy to crystalline, fossiliferous limestone, each about 1 foot thick, higher up in the sequence. In one of these the two goniatite species described below as *Metalegoceras campbelli* and *Uraloceras irwinense* were found by a field party of the University of Western Australia (including the junior author) in 1949. This bed is 150 feet stratigraphically above the horizon with *Metalegoceras jacksoni*, and, in addition to the goniatites, contains a rich fauna, including *Conularia sp.*, *Hyolithes sp.*, serpulid burrows, crinoid stems, *Fenestella sp.*, *Linoproductus sp.*, *Chonetes pratti*, two species of spiriferids, *Allorisma sp.*, three additional species of pelecypods, two species of pleurotomarid gastropods, two species of orthoceroids, *Stearoceras sp.*, and three species of ostracodes. *Metalegoceras campbelli* also occurs near the top of the Holmwood shale where it was found by J. Saunders (oral communication).

In order to explain the peculiarities of lithology and fossil content of the sequence now known as the Holmwood shale, Woolnough (1938) envisaged the Irwin River area during the time when this formation was laid down as an extensive bight almost entirely separated from the open ocean to the north and northwest by a low bar, very little above sea level. Intake of water over the bar was such that, although concentration to the point of deposition of salt and gypsum beds was precluded, high salinity restricted colonization by marine organisms. The thin bed crowded with *Metalegoceras jacksoni* may have been due to a phenomenally persistent onshore wind which piled up the ocean to the point where it temporarily broke through the bar, carrying with it enormous numbers of these pelagic organisms. The bar quickly reformed. Inside the basin a bed crowded with these ammonoids would thus result, with no sign of fossil life immediately either above or below it. Woolnough, however, did not know of the existence of several additional fossil horizons in the Holmwood shale, above the *Metalegoceras jacksoni* bed. These may perhaps be explained by later sporadic failures of the bar, but at least some of them contain a fauna that is so rich and varied that it must have been autochthonous. It is true, however, that the depositional environment of the Holmwood shale was not generally suitable for a rich benthonic life.

STRATIGRAPHIC CORRELATION

When he described *Gastrioceras jacksoni*, Etheridge (1907) came to the conclusion that "the facies of these organic remains is eminently that of the Carboniferous as distinguished from the higher Permo-Carboniferous." An important advance was made in 1923 when Dun and David pointed out "the great similarity, if not the absolute identity of *Gastrioceras jacksoni*, Etheridge, from the Irwin River Coal-field, and *Paralegoceras sundaicum* Haniel, from the Island of Letti." Thomas (1931) also believed that the affinities of the Irwin River species were with *Paralegoceras*, more particularly "with American Pennsylvanian species."

Miller, in 1932, however, proved that *Gastrioceras jacksoni* belonged in Schindewolf's then newly created genus *Metalegoceras*. He pointed out that its affinities were with species from the Permian of Timor, the Artinsk region of the Urals, and Texas. The species of *Metalegoceras* from the Somohole and Bitauni beds of Timor were found to be most similar to, though not conspecific with, *Metalegoceras jacksoni*.

A Sakmarian age was ascribed to *Metalegoceras jacksoni* by Teichert (1941) because of the primitive nature of its suture. He maintained that although the genus *Metalegoceras* is found as high as the Basleo beds of Timor and the Kungurian of the

U.S.S.R., "the state of development of *Metalegoceras jacksoni* suggests a Sakmarian rather than an Artinskian age."

When mature specimens of *Metalegoceras jacksoni* (maximum recorded diameter being 205 mm.) and *Metalegoceras campbelli* (maximum recorded diameter 11.4 mm.) are compared, it is seen that the former has a much more highly developed suture than the latter. However, immature stages of *Metalegoceras jacksoni* are almost indistinguishable from specimens of *M. campbelli* of corresponding diameters. The possibility that *M. campbelli* represents a dwarf development of *M. jacksoni* due to an environment of abnormally high salinity seems to be precluded by the fact that the associated fauna is of normal aspect, and also because *M. campbelli* occurs at two stratigraphically widely separated horizons. In respect to the development of its suture, *M. campbelli* is the most primitive of the known species of this genus. *M. distale*, the species most closely related to *M. campbelli* is found in the Kurmaia horizon of the Sakmarian of European Russia, suggesting close stratigraphical correlation of the two occurrences.

Uraloceras irwinense is closely comparable to several species of *Uraloceras* from the Sakmarian and Artinskian of the Ural mountains. It lies nearest to *Uraloceras burtiense limatulum*, an upper Sakmarian form. This confirms the Sakmarian age and affinities with European Russia suggested by *Metalegoceras campbelli*.

PALEONTOLOGICAL DESCRIPTIONS

Genus METALEGOCERAS Schindewolf 1931

This genus is known from the Lower and Middle Permian throughout a wide geographic range. It would seem that the following species should be referred to it:—*Paralegoceras sundaicum* Haniel and *P. evolutum* Haniel from the Somohole and Bitauni of Timor and Letti; *P. australe* Smith, *P. gigas* Smith and *P. wanneri* Smith from the Bitauni of Timor; *P. tschernyschewi* Karpinsky from the Artinskian of the Urals and the Bitauni of Timor; *Metalegoceras distale* Ruzhencev from the Sakmarian of the Ural Mountains; *Dodecalegoceras razumovskajae* Voinova, *D. sunidukiensis* Voinova, *D. evolutum uralense* Voinova, *D. sundaicum uralense* Voinova, *Asianites ajdaralense* Ruzhencev and *A. sogurense* Ruzhencev from the Artinskian of the Urals; *Metalegoceras clarkei* Miller and *M. striatum* Teichert from the Nura Nura limestone, and *Gastrioceras jacksoni* Etheridge from the Holmwood shale, Western Australia; *Metalegoceras colemanense* Plummer and Scott from the Admiral formation of Texas; *Goniatites baylorensis* White from the Wichita-Albany group of Texas; *Metalegoceras aricki* Plummer and Scott of the Wolfcamp formation of Texas; and *Metalegoceras schucherti* Miller and Furnish from the Leonard formation of Texas. *Gastrioceras somoholense* Haniel from the Somohole of Timor, a species considered by some to be based on immature representatives of *Metalegoceras evolutum* may also be added to this list. Ruzhencev described but did not name another new species of *Metalegoceras* from the Sakmarian of the Urals. *Paralegoceras incertum* Böse from the Gaptank formation of Texas, thought to belong to the genus *Metalegoceras*, is now the genotype of *Emilites* Ruzhencev (1938).

Oyens (1933) cast doubt on the validity of the Timor species established by Smith. He subjected this group to a close study of their conch proportions, but from a consideration of Smith's work it would seem that a closer analysis of suture patterns is necessary before specific boundaries can be fixed.

Oyens states that "the lobes are narrow pointed, the saddles rounded, the septa, as a whole, being identical for the whole group." However, in the adolescent sutures of *Metalegoceras wanneri*, and *Metalegoceras sundaicum* s.s. there are important differences which make it difficult to support the conclusion that they are conspecific.

At a conch diameter of 14 mm. the suture line of *Metalegoceras wanneri* has an extremely shallow umbilical lobe (Smith 1927, pl. 7, fig. 9) which is flanked on the umbilical shoulder and umbilical seam by lobes over four times its depth. The mature suture (loc. cit. pl. 7, fig. 6) however shows the umbilical lobe to be as deep as either of the lobes which flank it. This would seem to suggest a high possibility that *M. wanneri* did not rise directly as the result of the tripartition of the umbilical lobe of an eight-lobed form as suggested for *Metalegoceras* by Miller (1932). Rather does it indicate

derivation from a ten-lobed *Paralegoceras*-like form with an extra pair of lobes added by the development of a lobe on the umbilical saddle.

Metalegoceras sundaicum exhibits a normal *Metalegoceras* line of development. Smith (pl. 2., fig. 19) shows that even at a diameter of 10 mm. the umbilical lobe is well developed, very much more so than

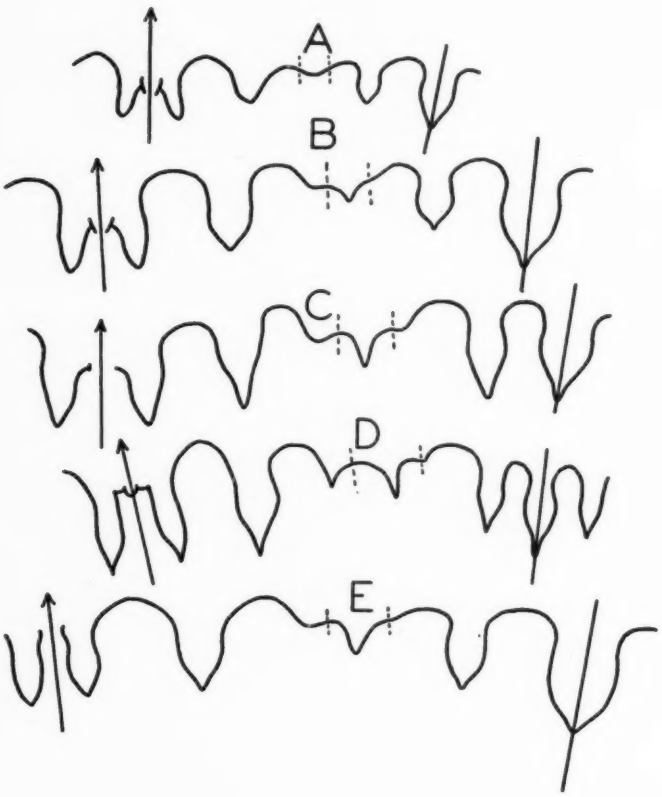

FIG. 3—Diagrammatic representations of the sutures of species of *Metalegoceras* from the Holmwood shale, Irwin Basin, Western Australia. A–D, *Metalegoceras jacksoni;* A, conch diameter =7 mm: B, conch diameter =10 mm: C, conch diameter=18 mm: D, mature suture at 70 mm. conch diameter. E, *Metalegoceras campbelli* Teichert and Glenister, n. sp., mature suture at 12 mm. conch diameter.

either of the lobes which flank it. Thus the lobes on the umbilical shoulder and seam would appear to have arisen by tripartition of the primary umbilical lobe of an eight-lobed *Gastrioceras*-like form.

METALEGOCERAS JACKSONI (Etheridge)
Plate 3, figures 1–6; plate 4, fig. 1

1907. *Gastrioceras jacksoni* ETHERIDGE, Geol. Surv. West. Aust. Bull., no. 27, pp. 36–37, pl. 9, figs. 1–3.
1923. *Gastrioceras jacksoni* ETHERIDGE, DUN & DAVID, Roy. Soc. New South Wales, Jour. and Proc. for 1922, vol. 56, pp. 249–252, pls. 11–13.
1929. *Paralegoceras jacksoni* (Etheridge), THOMAS, Nature, vol. 123, pp. 946–948.
1932. *Metalegoceras jacksoni* (Etheridge), MILLER, Amer. Jour. Sci., 5th ser., vol. 24, pp. 433–442, 1 pl.
1942. *Metalegoceras jacksoni* (Etheridge), TEICHERT, Jour. Paleontology, vol. 16, pp. 229–230 text-fig. 6B.

Forty specimens of *Metalegoceras jacksoni*, including the holotype, have been examined by the present authors. Mature representa tives are globose with a broad flatly depressed whorl cross section (pl. 4, fig. 1), the thickness of the last whorl (T) averaging 1.55 times the height of the whorl (H). The ventral surfaces of the whorls are broadly and uniformly convex, and connected with the concave dorsal surface by sharply rounded flanks. The involution (I) averages about one-third of the height of the whorl (H). The umbilicus has a diameter (U) which is only one-third as large as the corresponding shell diameter (D). Up to a diameter of 4

mm. the conch is evolute and thinly discoidal. After that the shell becomes moderately involute. Thus the first three whorls and relatively large protoconch (pl. 3, fig. 6) form an almost flat bottom to the steep sided umbilicus. The siphon is marginal down to the smallest observed shell diameter (2 mm.).

Both transverse and longitudinal lirae are a prominent feature of the early parts of the shell. They become less pronounced as the mature section of the conch is approached and are seen only with great difficulty in the outer whorls of some of the larger specimens. At a conch diameter of 50 mm. there are 6 transverse lirae per mm. The longitudinal lirae are less regular than the transverse ornamentation. Growth lines are present throughout. Their course is the same as that of the transverse lirae, bending slightly anteriorally on the flanks and turning into a shallow posteriorally directed sinus on the venter. Three constrictions per whorl (pl. 3, fig. 1) are present, each forming a broad, shallow, anteriorally directed saddle interrupted by a posteriorally directed sinus as it crosses the venter. As maturity is approached, the constrictions as a whole become less distinct and almost entirely disappear across the venter. Constrictions have been observed up to diameters of 70 mm. but it is probable that they occur in still older portions of the shell and have not been detected because of the poor preservation of these whorls.

Specimens with up to 13 whorls, one of which consists of body chamber, are known. The largest representative of this species seen by us has a greatest diameter of 205 mm., although part of the living chamber is missing. Dun and David (1923) report a fragment of a shell which might have reached 337 mm. diameter. This places *Metalegoceras jacksoni* among the largest known Paleozoic ammonoids.

The mature suture (fig. 3d) consists of 12 pointed lobes and 12 intervening rounded saddles, the ventral lobe being indented to three-quarters of its length by a prominent ventral saddle. The first lateral lobe is the deepest. It is sharply pointed adapically and constricted adorally. A shallow, bluntly pointed lobe is found on the umbilical shoulder followed by a deeper, narrower umbilical lobe. A shallow, broadly rounded lobe on the umbilical seam occurs in mature sutures. The internal suture consists of a long, sharply pointed, adorally constricted dorsal lobe flanked by a pair of similarly shaped laterals about two-thirds the size of the dorsal lobe. Saddles are broadly rounded throughout. At a conch diameter of 7 mm. (fig. 3a) there is only one single broad lobe extending from the umbilical seam to the umbilical shoulder. At a conch diameter of 10 mm. (fig. 3b) a shallow rounded lobe appears on the umbilical shoulder. At 15 mm. conch diameter the lobe on the umbilical seam makes its appearance so that at this stage of development all the elements of the mature suture are present. Up to a whorl diameter of 20 mm. the ventral lobe is deeper than the first lateral lobe. At conch diameters of 20 mm. they are equal in depth, and at all greater diameters the first lateral lobe is the deepest lobe of the suture.

TABLE 1—DIMENSIONS (IN MM.) OF EIGHT SPECIMENS OF *Metalegoceras jacksoni*.

	Holotype	A	B	C	D	E	F	G
Diameter (D)	106	205	173	130	125	97	62	29
Height of last whorl (H)	40	92	68	57	57	38	25	11.5
Height of penultimate whorl	26		36	34	30	24	16	5.4
Height of last whorl above venter	24	50	47	34	34	25	17	7.1
Involution (I)	16	42	21	23	23	13	8	4.4
Thickness of last whorl (T)	70	125	110	88	92	59	39	18.9
Thickness of penultimate whorl	38		62	57	57	38	25	11.1
Width of umbilicus (U)	35	88	52	50	49	32	17	10.0

Occurrence.—Abundant in a single bed 930 feet stratigraphically above the base of the Holmwood shale, outcropping along several lines, repeated by strike faulting, in

TABLE 2—SHELL RATIOS IN *Metalegoceras jacksoni.*

	U/D	I/H	T/H	T/D
Holotype	.33	.40	1.75	.66
A	.43	.46	1.36	.61
B	.30	.31	1.62	.64
C	.39	.40	1.54	.68
D	.39	.40	1.61	.74
E	.33	.34	1.55	.61
F	.27	.32	1.56	.63
G	.34	.38	1.64	.65

different parts of the Irwin Basin. The holotype came from "One and a quarter miles south west of Gnoolowa Hill" (Etheridge 1907, p. 37).

Repository.—Holotype no. 11980, and hypotypes nos. 32030a–d, Department of Geology, University of Western Australia.

Comparisons.—Since in the genus *Metalegoceras* the lobes on the umbilical seam and shoulder are ontogenetically the last to develop, their relative size may be used as an indication of the evolutionary stage reached by individual species.

The suture of *Metalegoceras colemanense* shows a superficial resemblance to that of *M. jacksoni. M. somoholense, M. distale* and possibly the imperfectly known form *Metalegoceras sp.* (Ruzh.) have sutures which are more primitive than those of *M. jacksoni* whereas all other species included by the present authors under the genus *Metalegoceras* exhibit more advanced suture lines.

Not only in the suture pattern, but also in its shell ratios is *M. jacksoni* rather distinct. Most of the Ural Mountains species are too dissimilar as regards conch proportions to this Irwin River form to warrant discussion. *Metalegoceras evolutum, M. evolutum uralense, M. somoholense, M. striatum, M. schucherti* and *M. colemanense* are much more widely umbilicate, *M. australe, M. sundaicum, M. sundaicum uralense* and *M. gigas* are narrower, while *M. aricki* and *M. ajdaralense* have markedly flatter whorls. *Metalegoceras wanneri, M. clarkei* and *M. baylorense* are similar to *M. jacksoni* in their conch proportions but may be easily distinguished by their suture lines. The large dimensions attained by mature individuals of *M. jacksoni* are rarely encountered in other species of this genus. A detailed comparison with *M. campbelli*, will be given in the discussion of this new species.

METALEGOCERAS CAMPBELLI Teichert and Glenister, n.sp.
Plate 3, figures 7–9

This species is named in honour of W. D. Campbell, who made the first detailed geological map of the Irwin Basin in 1909.

Description of holotype (no. 1981).—The holotype is a well-preserved specimen consisting of seven whorls, one of which is occupied by body chamber. In cross section the whorls are flatly depressed, the ratio of the thickness of the last whorl (T) to the height of the last whorl (N) being 1.81. The ventral surface is broadly rounded, the ventrolateral shoulders are subrectangular and the flanks flat. The umbilical shoulder is sharply rounded and the umbilical wall rather flat. The uniformly concave dorsal surface has an involution (I) which is equal to 0.47 of the height of the whorl (H). Up to a diameter of 2.5 mm. the shell is thinly discoidal and evolute, and thus forms a flat bottom to the umbilicus. After this diameter is reached the shell becomes in-

TABLE 3—DIMENSIONS (IN MM.) OF FOUR SPECIMENS OF *Metalegoceras campbelli.*

	Holotype	A	B	C
Diameter (D)	11.4		4.6	4.3
Height of last whorl (H)	4.7	3.4	1.1	1.5
Height of penultimate whorl	3.4		.9	.7
Height of last whorl above venter	2.5	1.9	.8	1.1
Involution (I)	2.2	1.5	.3	.4
Thickness of last whorl (T)	8.5	7.3	2.8	2.2
Thickness of penultimate whorl	5.7		1.75	1.3
Width of umbilicus (U)	4.5		2.6	1.8

creasingly more involute until the ratio of the width of the umbilicus (U) to the corresponding diameter of the conch (D) reaches 0.39 in the last whorl.

Prominent transverse lirae may be seen throughout the conch and much fainter growth lines and longitudinal lirae are occasionally seen in the better preserved portions of the shell. There are four transverse lirae per mm. at a conch diameter of 10 mm. The transverse lirae bend adorally into a broad saddle indented across the venter by a shallow adapically directed sinus. Three anteriorally directed constrictions are present in each whorl. They are most pronounced along the flanks, but become quite shallow across the venter.

Description of paratypes (nos. 32031–32035).—Six specimens of *M. campbelli* beside the holotype were available to the authors. Most of the shell is retained on the holotype with the result that the suture line can not be seen. At a conch diameter of 12 mm., the suture of paratype no. 32031 has 12 lobes and 12 saddles (fig. 3E). The ventral lobe is indented to three-quarters of its length by a ventral saddle, thus giving two-pointed, adorally constricted lobes. These are separated by a large rounded saddle from the sharply pointed, medially swollen, adorally constricted first lateral lobe. Another broadly rounded saddle separates the first lateral lobe from a small shallowly rounded lobe situated slightly ventral to the umbilical shoulder. The umbilical lobe is V-shaped, symmetrical and sharply rounded adapically. An incipient lobe occurs on the umbilical seam. The dorsal lobe and the single pair of internal lateral lobes are pointed adapically, inflated medially, and constricted adorally. They are almost identical in shape, but the internal laterals are only two-thirds the size of the dorsal lobe, which is the largest lobe of the complete suture. Up to a conch diameter of 7 mm. one single shallow lobe extends completely across the umbilical wall from the umbilical shoulder to the umbilical seam. At a shell diameter of 7 mm., a shallow lobe appears on the umbilical shoulder and at 10 mm. conch diameter the lobe on the umbilical seam makes its appearance. Thus at a conch diameter of 10 mm. all the elements of the mature suture are present. The siphon is marginal down to the smallest shell diameter at which it is observed (2 mm.).

TABLE 4—SHELL RATIOS IN *Metalegoceras campbelli.*

	U/D	I/H	T/H	T/D
Holotype	.39	.47	1.81	.75
A		.44	2.15	
B	.57	.27	2.55	.61
C	.42	.27	1.47	.51

Occurrence.—The type locality of *Metalegoceras campbelli* is situated 1200 yards on a bearing of 160° from the junction of the north and south branches of the Irwin River, where it occurs close to the top of the Holmwood shale. *M. campbelli* is also found associated with *Uraloceras irwinense* in a thin sandy to crystalline limestone band 150 feet stratigraphically above the band of *Metalegoceras jacksoni.* The band outcrops at a small area 200 yards west of the Nangetty-Holmwood boundary fence and 1 mile NW of Prider's Lookout as well as in the southern part of the Irwin Basin south of the Lockier River. This horizon is about 550 feet stratigraphically below that of the type locality.

Repository.—Holotype (no. 1981), Department of Geology, University of Melbourne. Paratypes (nos. 32031–32035), Department of Geology, University of Western Australia.

Comparisons.—*Metalegoceras campbelli* has a suture line which is more primitive than that of any other known species of the genus. In its primitiveness, *M. distale* is close to the described species, but has lobes on the umbilical shoulder and seam which are slightly, though distinctly, more advanced than those of *M. campbelli. M. razumovskajae, M. sogurense, M. sp.* (Ruzh.), *M. somoholense* and *M. colemanense* have sutures that are somewhat more advanced than those of *M. campbelli* and *M. distale.* All remaining species of *Metalegoceras* have more highly advanced sutures with strongly developed lobes on the umbilical shoulder and the umbilical seam.

In its conch proportions, *M. campbelli* is quite unlike the mature representatives of any other species of *Metalegoceras. M.*

distale, *M. razumovskajae*, *M. sogurense* and *M. colemanense* are much more widely umbilicate than *M. campbelli; M. baylorense* and *M. ajdaralense* have a slightly smaller umbilicus and their shell measurements are larger generally, whereas *M. aricki* has whorls which are markedly thicker in proportion to their height than those of the species under discussion. *M. sundaicum uralense* and *M. evolutum uralense* have whorls which are higher in proportion to their thickness than those of *M. campbelli*.

The large Timor forms are readily distinguished from *M. campbelli* when mature representatives are compared, but the *Gastrioceras* stage of *M. wanneri* has shell proportions which are strikingly similar to those of *M. campbelli*. The sutures of these two species are, however, quite different in all ontogenetic stages.

Mature representatives of *M. campbelli* and *M. jacksoni* bear little resemblance. However, if specimens of the same size of the two species are compared, it is difficult to detect any differences. In other words, mature individuals of *M. campbelli* appear to be identical with similar sized, immature stages of *M. jacksoni*. This applies to the details of the suture as well as to the ornamentation and proportions of the conch. Nevertheless, the normal aspect of the associated fauna and the uniformity of the size attained by representatives of the species may be taken as an indication that we are not dealing with a stunted form but with a normally developed species. *M. campbelli* is among the smallest species referred to *Metalegoceras*.

Genus Uraloceras Ruzhencev 1936

Ruzhencev established the genus *Uraloceras* for gastrioceratids intermediate in conch proportions between *Paragastrioceras* and *Pseudogastrioceras*. He distinguished *Uraloceras* from these two genera not only by means of conch proportions, but also by the different proportions of the width of the branches of the ventral lobe and the first lateral lobe, as already noted by Karpinsky in his comparison of *Goniatites jossae* and *Gastrioceras suessi*. As the genotype of *Uraloceras*, Ruzhencev proposed *Gastrioceras suessi* and included the following additional species: *Gastrioceras gerkeni* Fredericks, *Paragastrioceras involutum* Voinova, *Paragastrioceras burtiense* Voinova, *Paragastrioceras kirghizorum* Voinova, *Gastrioceras fedorowi* Karpinsky, *Gastrioceras roadense* Böse, *Gastrioceras altudense* Böse, and *Gastrioceras waageni* Gemmellaro.

Miller and Furnish (1940, p. 82) stated that *Gastrioceras suessi* "does not seem to differ sufficiently from the genotype of *Pseudogastrioceras* to be regarded as representing a distinct genus." They also maintained that an almost complete gradation between the genotypes of *Paragastrioceras*, *Pseudogastrioceras* and *Strigogoniatites* was observable.

The present authors agree with Miller and Furnish that there is almost complete gradation between the genotypes of *Paragastrioceras*, *Uraloceras*, *Altudoceras*, *Pseudogastrioceras*, *Strigogoniatites* and *Atsabites*, although the genotypes are themselves quite distinct and definite groups do occur. Strictly then, these six groups should be regarded as belonging to the one genus, each group assuming subgeneric rank. Since, however, the erection of subgenera among upper Paleozoic ammonoids has not been common practice, it seems best to afford generic rank to these six groups. A brief discussion of the characteristics of each group is given below.

Pseudogastrioceras Spath with its genotype *Gastrioceras abichianum* (Möller), (pl. 2, figs 8–9), includes narrowly umbilicate gastrioceratids in which nodose umbilical zones and constrictions are not prominent conch features at maturity. In 1936 Ruzhencev established *Goniatites jossae* de Verneuil (pl. 2, figs. 12–13) as genotype of *Paragastrioceras*. This genus includes widely umbilicate species with broad flat subtrapezoidal whorl cross sections. Transverse constrictions and prominent umbilical nodes are maintained even at maturity. The branches of the ventral lobe of species of *Paragastrioceras* are generally narrower than the first lateral lobe.

For the large group of gastrioceratids intermediate in conch proportions between *Pseudogastrioceras* and *Paragastrioceras*, Ruzhencev proposed the generic name of *Uraloceras*. They are discoidal, evolute, widely umbilicate forms with laterally compressed whorl cross sections. Constric-

tions are present during all growth stages. In their immature whorls, pronounced umbilical tubercles are occasionally present, but in the mature whorls, these tubercles and nodose ribs are either weakly developed or absent. The branches of the siphonal lobe of most species of *Uraloceras* are almost equal in size to the first lateral lobe.

In 1940 Ruzhencev separated from *Uraloceras* a new genus, *Altudoceras;* with *Gastrioceras altudense* Böse, (Plate 2, figs. 10–11), as genotype. The major difference between these two genera is that whereas the constrictions and transverse ornamentation of *Uraloceras* form an adorally directed arch as they cross the venter, those of *Altudoceras* form an adapically directed sinus. *Altudoceras* thus includes *Gastrioceras roadense* Böse from Texas and most of the species previously referred to the group of *Gastrioceras zitteli* Gemmellaro.

Strigogoniatites Spath was established in 1934, with *Glyphioceras angulatum* Haniel as genotype, for narrowly umbilicate forms similar to *Pseudogastrioceras* but differing from the latter by their angular venter. Haniel in 1915 established *Atsabites* with *Atsabites weberi* as genotype for highly evolute, flatly discoidal gastrioceratids with pronounced umbilical ribs and rounded venters.

URALOCERAS IRWINENSE Teichert and Glenister n.sp.
Plate 4, figures 2–7

Description of holotype (no. 32036).—The shell is discoidal, evolute, and has a laterally compressed whorl cross section (pl. 4, fig. 5), the greatest thickness (T) of the whorls being slightly larger than the height (H). Both the venter and flanks are strongly convex with an almost uniform curvature along the flanks and across the venter. Dorsally, the flanks curve sharply towards the umbilicus and the umbilical wall is low, but steep. The dorsal surface is uniformly concave, its involution (I) being approximately one-quarter the height of the whorl (H). The diameter of the umbilicus at the umbilical shoulder (U) is slightly less than one-half the diameter of the conch. Eight complete volutions may be seen, the whole of the last one consisting of body chamber.

The surface of the shell is marked by closely spaced longitudinal and transverse lirae, giving it a finely reticulate pattern. The transverse lirae are generally more prominent and more irregular than the longitudinal lirae, especially on the flanks and low rounded umbilical walls where in many cases the former bifurcate or have finer lirations interposed between the coarser. Towards the venter the ornamentation becomes more regular. At a conch diameter of 20 mm. there are four transverse lirae per mm. on the umbilical wall while there are six per mm. on the venter. Six longitudinal lirae per mm. cover the whole visible external surface of the shell. Although they are as prominent as the transverse lirations on the venter, it is only with great difficulty that the longitudinal lirae may be observed on the umbilical walls and adjoining portions of the flanks. This ornamentation is uniform in all ontogenetic stages of the

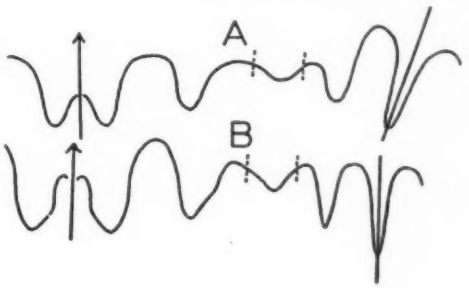

FIG. 4—Diagrammatic representations of the sutures of *Uraloceras irwinense* Teichert and Glenister, n. sp. from the Holmwood shale, Irwin Basin, Western Australia. A, conch diameter = 4 mm.: B, mature specimen of conch diameter = 11 mm.

conch and never grades into tubercles or nodose ribs. Transverse lirae are much finer and more numerous in the constrictions than on the general shell surface. The transverse lirae and prominent constrictions, of which there are four to each volution of the conch, are directed radially across the umbilical wall until they reach the dorsolateral shoulder, where they are directed adorally, forming a pronounced fold across the venter. Six or seven prominent costae are found between each constriction. They bend sharply adorally from their starting point on the umbilical shoulder but become indistinct and finally disappear as they approach the venter.

Description of paratypes (nos. 32037–32040).—Nineteen specimens of *Uraloceras irwinense*, besides the holotype, were available to the authors. Most of the shell is intact on the holotype and thus the sutures are not visible. Paratype no. 32037 shows a simple gastrioceran suture (fig. 4B) with eight pointed lobes and intervening rounded saddles. The wide ventral lobe is indented to half its height by a ventral saddle. Both branches of the ventral lobe are tongue-shaped and bluntly pointed. The bluntly pointed first lateral lobe has approximately the same depth and width as the branches of the ventral lobe. A wide shallow umbilical lobe occurs near the point of involution. The internal suture consists of a pair of narrow deep sharply pointed lateral lobes and a similarly shaped but deeper dorsal lobe. In the earlier whorls the eight lobes are shallower and gently rounded (fig. 4A). The siphon is marginal down to the smallest diameter at which it has been observed (2 mm.).

Occurrence.—*Uraloceras irwinense* is found associated with *Metalegoceras campbelli* in a thin sandy to crystalline limestone band 150 feet stratigraphically above the band of *Metalegoceras jacksoni*. The type locality is 200 yards west of the Nangetty-Holmwood boundary fence, and 1 mile NW of Prider's Lookout.

Repository.—Holotype (no. 32036) and paratypes (nos. 32037–32040), Department of Geology, University of Western Australia.

Comparisons.—*Uraloceras irwinense* is the smallest species of *Uraloceras* yet recorded. Mature representatives of most other species of this genus have diameters at least twice that of the holotype of *U. irwinense*. There is no great variation in suture pattern between different species of *Uraloceras* but variations in conch proportions and ornamentation are marked.

U. burtiense (Voinova), *U. burtiense limatulum* (Ruzhencev), *U. involutum* (Voinova), *U. fedorowi* (Karpinsky), *U. suessi* (Karpinsky) and *U. gerkeni* (Fredericks) have a smaller umbilicus than the described specimen. The whorl cross sections of *U. kirghizorum complanatum* (Voinova) and *U. subgerkeni* (Ruzhencev) are higher in relation to their thickness than those of *U. irwinense*. The coarse transverse costae of *U. kirghizorum* "typica" (Voinova) and *U. kirghizorum solidum* (Voinova) are not typical of the Irwin River species while the pronounced longitudinal furrows which *U. waageni* (Gemmellaro) exhibits across the venter are unknown in *U. irwinense*.

TABLE 5—DIMENSIONS (IN MM.) OF EIGHT SPECIMENS OF *Uraloceras irwinense*.

	Holotype	B	C	D	E	F	G	H
Diameter (D)	21.2	19.6	16.9	15.2	14.9	14.3	13.9	11.5
Height of last whorl (H)	6.5	6.4	5.2	5.0	4.6	4.2	4.6	3.6
Height of penultimate whorl		3.7	2.7	2.5	2.4	2.2	2.2	1.5
Height of last whorl above venter		5.3	4.6	3.8	3.7	2.9	3.7	2.9
Involution (I)		1.1	.6	1.2	.9	1.3	.9	.7
Thickness of last whorl (T)	7.2	7.1	7.3	4.6	6.0	5.2	4.9	4.5
Thickness of penultimate whorl		4.3	3.1	3.2	4.1	3.2	3.0	2.3
Width of umbilicus (U)	10.0	9.3	7.2	7.1	7.4	7.4	6.3	5.4

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TABLE 6—SHELL RATIOS IN *Uraloceras irwinense*.

	U/D	I/H	T/H	T/D
Holotype	0.47		1.18	0.34
B	0.47	0.17	1.11	0.36
C	0.42	0.12	1.40	0.43
D	0.47	0.24	0.92	0.30
E	0.49	0.20	1.30	0.40
F	0.52	0.31	1.24	0.36
G	0.45	0.20	1.07	0.35
H	0.47	0.19	1.25	0.39

Australia, and to Mr. J. A. Saunders, of the Melbourne Technical College, who placed at our disposal some specimens collected by himself. To Dr. R. W. Fairbridge we wish to express our gratitude for the original drawings of text-figures 2 and 3 which he made available to us for publication.

BIBLIOGRAPHY

CLARKE, E. DE C., PRENDERGAST, K. L., TEICHERT, C. and FAIRBRIDGE, R. W., 1951, Permian succession and structure in the northern part of the Irwin Basin, Western Australia: Roy. Soc. West. Australia, Jour., vol. 35, (1948–49), pp. 31–84, 1 map.

DUN, W. S., and DAVID, T. W. E., 1923, Notes on the occurrence of *Gastrioceras* at the Irwin River Coal-field, W. A., and a comparison with the so-called *Paralegoceras* from Letti, Dutch East Indies: Roy. Soc. New South Wales, Jour. and Proc. for 1922, vol. 56, pp. 249–252, pls. 11–13.

ETHERIDGE, R., 1907, Description of Carboniferous fossils from the Irwin River, collected by Mr. C. F. V. Jackson: Geol. Surv. West. Aust. Bull., no. 27, pp. 26–37, pls. 3–10.

GEMMELLARO, G. G., 1899, La Fauna dei Calcari con *Fusulina* della Valle del Fiume Sosio nella Provincia di Palermo: Societa di Scienzi Naturali ed Economiche, Palermo.

HANIEL, C. A., 1915, Die Cephalopoden der Dyas von Timor: Palaont. v. Timor. 3, Lief. 6, pp. 1–153, pls. 46–56.

KARPINSKY, A. P., 1891, Von den Ammoneen der Artinskschen Etage und von einigen denselben verwandten Carboniferen Formen: Vserosiiskoe Mineralogischeskoe Obshchestvo, Zapiski (K. mineralogischen Gessellschaft zu St. Petersburg, Verhandlungen), series 2, vol. 27, pp. 15–208, pls. 1–5.

MILLER, A. K., 1932, *Metalegoceras jacksoni* of the Irwin River Coalfield, Western Australia: Am. Jour. Sci., 5th ser., vol. 24, pp. 433–442, pl. 1.

——, 1936, A new Permian ammonoid fauna from Western Australia: Jour. Paleontology, vol. 10, pp. 684–688, pl. 92.

——, 1944, Geology and paleontology of the Permian area northwest of Las Delicias, southern Coahuila, Mexico, Part 4, Permian Cephalopods: Geol. Soc. America Spec. Paper 52, pp. 1–172, pls. 1–45.

——, and FURNISH, W. M., 1940, Permian ammonoids of the Guadalupe Mountain region and adjacent areas: Geol. Soc. America, Spec. Paper 26, pp. 1–242, pls. 1–44.

OYENS, F. A. H. W. DE MC. 1933, On *Paralegoceras sundaicum* Haniel and related forms: Kon. Akad. Wetensch. Amsterdam, Proc., vol. 36, pp. 88–98, text figs. 1–5.

RUZHENCEV, V. E., 1933, Sur quelque Ammonoidea du Permian inférieur provenant de la région d'Aktioubinsk: Moskovskoe Obshchestv. Ispytatelei Privody (Société des Naturalistes de Moscou), Bulletin, Otdel Geologicheskii, vol. 11 (new series, 41), pp. 164–180, pls.

——, 1936, Paleontological notes on the Carboniferous and Permian Ammonoids: Sovetskaia Geologiia, vol. 6, pp. 1072–1088.

——, 1938, Ammonoids of the Sakmarian stage and their stratigraphic significance: Problemy Paleontologii (Problems of Paleontology), vol. 4, pp. 187–285, pls. 1–7.

——, 1939, Development of the family Metalegoceratidae Plummer et Scott: Akademiia Nauk U.S.S.R., Doklady (Academy of Sciences of the U.S.S.R., Transactions), vol. 24, pp. 310–312.

——, 1940, On the question of the taxonomic position of some of the Upper Paleozoic ammonites: idem, vol. 28, pp. 285–288.

SMITH, J. P., 1927, Permian ammonoids of Timor: Jaarb. Mijnwezen Nederl.-Indie (1926), vol. 45, Verhandel., pt. 1, pp. 1–58, pls. 1–16.

TEICHERT, C., 1941, The Upper Paleozoic of Western Australia: Correlation and Paleogeography, Am. Ass. Petroleum Geol. Bull., vol. 25, pp. 371–415.

——, 1942, Permian ammonoids from Western Australia: Jour. Paleontology, vol. 16, pp. 221–232, pl. 35.

——, 1951, The marine Permian faunas of Western Australia (an interim review): Paleont. Zeitsch., vol. 24, pp. 76–90.

THOMAS, H. D., 1929, The late Palaeozoic glaciation: Nature, vol. 123, pp. 946–948.

VOINOVA, E. V., 1934, Some ammonites from the Baigendja horizon of the Artinskian, South Urals: Russia, Vsesouiznaia Geologorazvedochnoe Ob'edinenie, Trudy (All-union Geological and Prospecting Institute, Transactions), fascicle 352, pp. 1–59, pls. 1–5.

WOOLNOUGH, W. G., 1938, Fact and theory in geology, with special reference to petroleum, salt, and coal: Rept. 23rd Meet. Australia New Zealand Assoc. Adv. Sci. (Auckland meeting), pp. 54–79.

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NEW ORDOVICIAN CEPHALOPODS FROM EASTERN NORTH AMERICA

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ABSTRACT—Thirty-seven species of nautiloids are described, mainly from the Mohawkian beds of New York and Quebec, but including a few forms from the Chazyan, as well as some Mohawkian forms from the Mississippi valley and Newfoundland. Three new genera are described, *Sinclairoceras*, *Lavaloceras* and *Avilionella*. Discussions and summary of distribution of the following genera, significant faunally, are included: *Murrayoceras*, *Cyrtocerina*, *Whitfieldoceras*, and the history of *Kionoceras* in the Ordovician is traced. In introduction a brief summary of Chazyan and Mohawkian cephalopod faunas is presented. Tentative lists of cephalopods from two important faunas are included, the unnamed lower Trenton or Black River assemblage of the Ordovician outlier at Chicoutimi and Lake St. Jean, and the Terrebonne, highest Trenton, of the Montreal region.

INTRODUCTION

THE number of undescribed nautiloids in the American Ordovician is appallingly large, and in general not realized by stratigraphers and paleontologists. In the present work are brought together descriptions which have accumulated over a period of years, representing in large part material submitted to the writer for study, usually in small lots. In some cases they represent only part of larger nautiloid faunas; in other cases they are those rare forms which are occasionally found in associations generally poor in nautiloids, but dominated by other types.

Major faunas now in process of study have contributed a few forms of exceptional interest. The first of these faunas is that of the Chazyan of the Champlain Valley, one of the prolific cephalopod assemblages of the country, important in that the fauna is the only Ordovician association thus far found which has yielded early stages in abundance in a condition of preservation which permits study of the interiors by means of sections; generally such early stages in other associations are badly recrystallized, retaining no trace of the siphuncle. The Chazyan fauna is a large and varied one, significant in that it marks the first appearance in America of genera, families and most of the orders which persist into higher Ordovician beds. The Endoceratida is represented there by the oldest of the true Endoceratidae, forms with long septal necks, and in general, a simple endocone pattern. There are here also a few endoceroids with remarkably specialized endocones, only one of which, *Meniscoceras coronense*, has been described (Flower, 1941). There are a few rare actinoceroids, including *Gonioceras chaziense* Ruedemann (1906), *Ormoceras champlainense* described below, while fragmentary material indicates the presence of the Armenoceratidae. We have here the first of the true Michelinoceratidae, Stereoplasmoceratidae, and the primitive Ascoceratida, representing only the subfamily Hebetoceratinae. *Graciloceras* Flower (1943), a probable modified survivor of the essentially Canadian Basslerocerati da, is one of the very few cyrtoconic genera with tubular siphuncles which survives the close of the Canadian. The Baltoceratidae are represented, though only in the basal beds, by *Baltoceras*, which extends no higher at least in America, and *Murrayoceras* which makes its first appearance here and becomes a significant type in the Mohawkian cephalopod faunas. The Oncoceratidae are represented by a number of types, mainly *Oncoceras* and *Beloitoceras*, though other genera have been found, including the specialized *Zitteloceras*, and it now appears that the Oncoceratidae in their first appearance may be fully as specialized as the Michelinoceratida. Here also appear the actinosiphonate Valcouroceratidae and the compressed breviconic Diestoceratidae, though members of this family in the Chazyan are still inadequately

known structurally. The coiled cephalopods, the Barrandeoceratida, are represented by the Plectoceratidae, and Barrandeoceratidae. The Tarphyceratida, which appear in the Canadian, are represented only by two species of *Trocholites;* it has long been known that the Trocholitidae persist from the Canadian through the Ordovician, and into the Middle Silurian, but the Tarphyceratidae I have been unable to recognize in the Chazyan or younger beds. *Tarphyceras multicameratum* Ruedemann (1906), common in the middle and upper Chazyan, is not a member of the Tarphyceratidae, but of the Barrandeoceratidae, and is made the type of a new genus, *Avilionella.* The anomalous cyrtocone with a central broadly expanded siphuncle, *Ruedemannoceras,* is as yet known only from the two species of the Champlain Valley Chazyan, *R. boyci* (Whitfield) and *R. champlainense* (Ruedemann), and *R. stonense* (Safford) of the Murfreesboro limestone of the central basin of Tennessee.

The Lowville limestone of New York has yielded a large cephalopod fauna, almost completely undescribed, and now only in process of preparation. Orthoceracones dominate the assemblage, with *Endoceras, Cyclendoceras, Actinoceras, Murrayoceras,* and a large assemblage of the Michelinoceratidae and possibly some Stereoplasmoceratidae. There are in addition some small cyrtocones and brevicones of the Oncoceratidae. The Lowville of Ottawa contains a very similar fauna, but yields specimens more readily in a state suitable for study. More surprising has been the discovery of a fauna of very similar aspect to that of the New York Lowville in the Carters limestone of Tennessee, a formation currently regarded as considerably younger than the Lowville itself.

The Chaumont limestone of New York, long known for its assemblage of large and conspicuous *Gonioceras* and *Actinoceras,* with occasional large endoceroids and the smaller coiled Plectoceratidae, contains in addition a considerable assemblage of smaller cephalopods including Michelinoceratidae, a recurrence of *Murrayoceras, Tofangoceras, Ormoceras,* as well as some cyrtocones and gyrocones of the Barrandeoceratidae, and some oncoceroids.

Beds currently classed as lower Trenton contain many survivors of Black River types which are unknown in overlying beds of middle Trenton age. The marked change in cephalopod faunas above rather than below the lower Trenton, suggests that a more natural faunal grouping would result if these beds were classed with the Black River instead of the Trenton. This is particularly striking in the fauna of the Paquette Rapids of the Ottawa River in Ontario, but is expressed elsewhere, as in the cephalopod association from Pont Rouge (Sinclair, 1945, Flower, 1945,) the affinities of which are, surprisingly, Platteville.

In contrast, the middle Trenton faunas of New York contain a relatively meagre cephalopod association in species if not in numbers of individuals. Here the association is dominated by *Michelinoceras tenuifilum* and allied species, with occasional large endoceroids. *Trocholites* occurs, but is common only in one very restricted band at the base of the Denmark member, and occasional oncoceroids also occur. In Quebec, the faunas are richer and more varied, but differ chiefly in the greater abundance and variety of oncoceroids.

The late Trenton beds are marked by a return to the region of a more varied cephalopod fauna. Some types appear which are reminiscent of those encountered in the Black River and lower Trenton faunas. With them are other types, genera encountered here for the first time in the geological column. Many are large and conspicuous forms, which have been previously known from the Red River faunas of Foerste, using the term in its broadest sense for not only the Red River formation, but boreal associations of similar aspect, from the Cape Calhoun beds of Greenland, the several Baffin Land assemblages, the Ordovician on the west side of Hudson Bay, the Red River faunas of the Winnipeg area, the cephalopod associations of the Bighorn dolomite and the Fremont limestone of Colorado. These associations have been regarded as Richmondian, and many genera not previously known outside of these associations have been considered diagnostic of Richmond time. Many of these genera are appearing in strata of unquestionably late Trenton age. The Cobourg of western New York and Ontario has yielded *Pro-*

billingsites, and unmistakable *Westonoceras* and *Charactoceras*, though description of these is delayed pending the discovery of better material. The highest Trenton, the Terrebonne formation, of Montreal has yielded *Winnipegoceras*, *Apsidoceras*, *Fremontoceras*, *Lambeoceras*, large *Diestoceras*, a genus which extends as far down as the Chazyan, but has previously been known in definitely pre-Richmond strata only by small species. Many genera of these boreal faunas remain which have not been found in the Trenton, but there are also many genera which have not been found in undisputable Richmond faunas.

This is true of the striking *Cyrtogomphoceras*, *Landeroceras*, *Wilsonoceras* and *Kochoceras*, as well as of the less conspicuous but equally significant *Shamattawaceras*, *Narthecoceras*, *Dowlingoceras*, *Whiteavesites*, *Ephippiorthoceras* and *Parksoceras*. Indeed, the nautiloid genera of the boreal assemblage which characterize the true Richmond and are unknown in the Trenton are by now practically confined to *Huronia*, *Billingsites* and *Schuchertoceras*. Of these, only *Schuchertoceras* appears in the type Richmond of the Cincinnati region. This is not an imposing assemblage. Kirk suggested (1925, 1930), that these boreal faunas may be in a large part Cincinnatian (Covington in the restricted sense, as a division of the Cincinnatian including Eden and Maysville and excluding Richmond). Certainly the Richmondian age of these beds has been quite widely accepted, and the discovery of many of the genera which characterize them in beds of late Trenton age is widely at variance with this conclusion. Present indications are that the variety of these late Trenton faunas in New York, Ontario and Quebec is far from exhausted.

Two of the cephalopod associations from which material is described here are worthy of special note. The first is the fauna from the basal part of the section of Ordovician rocks in the area of Chicoutimi and Lake St. Jean, Quebec. Here are massive limestones suggestive of the Black River in general aspect, with an anomalous mixture of Black River and later, indeed, some supposedly Richmondian types. There has been no formation name proposed for these rocks. The section and its faunas is now in process of study by Dr. G. Winston Sinclair. (See Dennis, 1932, Dresser, 1916, McGerrigle 1932, Raymond, 1916, Sinclair 1946.) The lower beds are massive limestones containing with *Columnaria*, *Receptaculites* and a *Streptelasma* resembling strongly the Richmondian *S. corniculum*, a considerable suite of cephalopods. Much of the material collected by the writer is too poorly preserved or too fragmentary to merit description, but the following types have been noted:

Actinoceras sp. This was cited by Barrande (pl. 434, fig. 9–10) as *Actinoceras anticostiense*. It is not this species, but rather one closely related to Black River types, *A. tenuifilum* and *A. ruedemanni*. Younger forms in the Hull equivalent in Quebec, and quite similar forms in the Bigby limestone of Tennesee, have much smaller siphuncles, and indeed, approach very closely in proportions the monotypic genus *Troostoceras*, from which they differ only in that the venter is straight rather than faintly exogastrically curved.

Michelinoceras? sp. At least two species of smooth orthoconic cephalopods, one retaining a trace of a tubular siphuncle.

Gorbyoceras? sp. Probably three species of annulated orthocones. One has the longitudinal markings and nummuloidal siphuncle of a typical *Gorbyoceras*, and is more similar to *Gorbyoceras clintoni* (Miller) of the Chazyan than to any other described form.

Westonoceras sp. A large form, known only from a natural vertical section showing the typical structure of the siphuncle.

Oncoceras (?) sp. Several oncoceroids, of varying sizes, representing at least three species. One, known thus far only from crushed material, is the largest of the *Oncoceras*-like shells thus far found in the Ordovician.

Sinclairoceras haha n. sp., described below.

Though the cephalopod elements are in many respects anomalous, this part of the section appears to be Black River or at the very latest, lower Trenton in age. The few cephalopods I have seen from the upper part of the limestones are quite different, including a *Deiroceras*, an anomalous form tentatively assigned to *Whitfieldoceras* and some small orthocones. This fauna is very different in lithology, certainly much younger, and is probably middle or early upper Trenton.

The Terrebonne formation in the vicinity of Montreal has yielded large conspicuous cephalopods, a few of which are described in the present paper. Here occur *Apsidoceras quebecense*, *Fremontoceras giganteum*, *Winnipegoceras sinclairi*, *Lambeoceras montrealense*, *Lavaloceras geniculatum*, *Diestoceras sinclairi*, *D. lavalense*. Additional elements, as yet undescribed, include poorly preserved large endoceroids, orthocones of the aspect of "*Orthoceras*" *tenuifilum*, small brevicones including *Neumatoceras*, *Oncoceras*, *Beloitoceras*, *Probillingsites*, and some additional larger *Diestoceras*. This is the highest Trenton in the vicinity of Montreal. The underlying Tetreauville formation has yielded a more sparse fauna, lacking some of the larger types, but certainly including *Apsidoceras montrealense* Flower (1943) *Lavaloceras*, *Diestoceras*, *Probillingsites* and some small oncoceroids.

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Order ELLESMEROCERATIDA
Genus CYRTOCERINA Billings

A full description of the genus and references to earlier citations of the genus were presented by Flower (1946, p. 504). At that time, several undescribed species were noted which, with a little additional material, are described here. The previously described forms are *C. typica* Billings, of the Black River of the Paquette Rapids of the Ottawa River, Ontario, *C. schoolcrafti* Clarke, of the Decorah shale of Minnesota, and the four species found in the Richmond of Indiana and Ohio, *C. madisonensis* (Miller), *C. patella* Flower, *C. modesta* Flower and *C.* (?) *carinifera* Flower. To these are now added *C.* sp., a small fragment from the Lowville beds of Ottawa, significant in that it is the oldest form thus far recorded, *C. crenulata* Flower of the Platteville of Wisconsin, *C. kimmswickensis* and *C. foerstei* from the Kimmswick limestone of Missouri.

A considerable stratigraphic gap still separates *Cyrtocerina* from *Eothinoceras*, the only closely related genus. *Eothinoceras* is from the Rochdale limestone of southeastern New York, of middle Canadian (Roubidoux) age. It differs from *Cyrtocerina* in its much more slender form. It is probably slightly curved endogastrically, rather than straight. As yet, the genera are separated by a stratigraphic gap comprising the entire upper Canadian and Chazyan.

CYRTOCERINA sp.
Plate 8, figures 19–20

A fragment of a *Cyrtocerina* from the Lowville at Ottawa presents the earliest record yet known for the genus. For this reason, the species is illustrated and described, but it is felt that more complete material should serve as the basis of a description before the form is named. The specimen expands rapidly from the apex to a height of 15 mm. and a width of 12 mm., the greatest width lying slightly ventrad of the center of the section. The apex is incomplete on our specimen, but the entire shell is strongly curved, rapidly expanding, and when complete must have attained the proportions noted above in an actual length of 12 mm. or slightly less, with the shell curving strongly enough to describe nearly a quarter of a volution. The surface bears fine lines of growth. The sutures are not displayed. Siphuncle ventral, relatively large, apparently expanding rapidly from adapical to adoral camerae, as is typical of the genus. In cross section this form is distinctive in the broadly rounded condition of the dorsum in cross section; in other forms it is subangular in the middle, more pointed. The sutures slope forward from venter to dorsum, but the growth lines are transverse.

Discussion.—This form is distinctive in the strong curvature, rapid expansion, and broadly rounded condition of the dorsum in cross section. Though proposal of a name for this form is delayed pending the discovery of better material, there can be no question but that it represents an undescribed species. In comparison to most forms the dorsum is more rounded, curvature is stronger. *C. typica* of the Paquette Rapids approaches our form in the broadly rounded dorsum, if Billings has illustrated this feature accurately, but the section of that species is much broader, and both the

curvature and the rate of expansion are markedly smaller.

Type.—Collection of G. Winston Sinclair.

Occurrence.—Lowville limestone, Ottawa, Canada.

CYRTOCERINA CRENULATA Flower, n. sp.
Plate 8, figures 17, 18

Cyrtoconic, rapidly expanding, endogastric; strongly compressed, with greatest width about halfway between center and venter, dorsum more narrowly rounded than venter. The type consists of a nearly complete phragmocone and the basal part of the living chamber, with a maximum length of 50 mm. Radius of curvature of dorsum ranges from 36 mm. adapically to 55 mm. adorally. Shell increasing from 7 and 10 mm. to 14 and 22 mm. in the basal 20 mm.; and to 22 mm. and 33 mm. in the next 20 mm., attaining adorally a shell height of 42 mm. (53 mm. from the base of the specimen), with an estimated width of 30 mm.

The internal mold shows shallow flat longitudinal grooves separated by elevated interspaces, faint adapically, prominent near the base of the living chamber, and closely spaced on the venter, widely spaced on the midlateral region, and fading out on the dorsum. The sutures are modified into crenulations corresponding in position to the grooves of the internal mold; they are otherwise essentially straight and normal to the curving axis of the shell. Adorally five camerae occupy 11 mm. on the dorsum, 5 mm. on the venter. The type preserved 34 camerae. On the venter, the siphuncle is circular in section at the base of the specimen, 1 mm. across where the shell height is 11 mm. It expands rapidly adorally, as is typical of the genus. Its structure has not been studied in detail, but the weathered portion exposed in the middle of the type shows no atypical features. Where the shell height is 20 mm., the siphuncle is 8 mm. across; its corresponding height is uncertain. Only the extreme base of the living chamber is preserved.

Discussion.—This is the largest species of *Cyrtocerina* thus far known, and may be readily distinguished from *C. schoolcrafti* by the more compressed section, the greater curvature, and the grooves of the phragmocone and the corresponding crenulations of the sutures. The grooves and intervening ridges are apparently internal expressions of a fluting of the very thin shell, and not, as in *Westonoceras*, the impressions made on internal molds of incipient cameral deposits.

Holotype.—U. S. National Museum, no. 15685.

Occurrence.—From the Beloit member of the Platteville formation, Beloit, Wisconsin.

CYRTOCERINA KIMMSWICKENSE
Flower, n. sp.
Plate 8, figures 3–5, 9, 10

A rapidly expanding endogastric cyrtocone, compressed, dorsum subangular in cross section, venter rounded, greatest shell width lying at center of cross section. Shell expansion and curvature moderate. The paratype increases from 10 and 12 mm. to 12 and 17 mm. in a dorsal length of 9 mm. and a ventral length of 5 mm. The holotype, a smaller but more complete shell, increases from 6 and 8 mm. to 10 and 14 mm. in a dorsal length of 12 mm. and a ventral length of 9 mm., the specimen having an actual length of 18 mm. The dorsum has a radius of curvature of 4.5 mm. The sutures, well displayed on the holotype, describe very shallow lateral lobes. The adoral four camerae occupy a length of 5 mm., in which the shell height increases from 9.5 to 13 mm. Adorally, the shell extends in part 5 mm. farther, but there is no indication of the aperture. The siphuncle is very obscurely indicated close to the ventral (concave) side of the shell. The surface shows transverse growth lines which fail to indicate a hyponomic sinus or other modifications. While the sutures slope somewhat orad from venter to dorsum, the growth lines are strictly transverse.

Discussion.—This species and the following have the cross section attaining its greatest width at the center, instead of well on the ventral side of the shell. This is found also in *C. typica* (Billings) where however, the dorsum is more broadly rounded and the adoral sutures are more strongly oblique. *C. kimmswickense* differs from *C. foerstei* in the gentler curvature of the dorsum, the more gradual expansion of the shell, and the narrow subangular condition of the dorsum in cross section, *C. foerstei* being more broadly rounded there. While preservation of the phragmocone of

C. foerstei is not all that might be desired in the present material, there is a strong suggestion that in *C. kimmswickense* the camerae are considerably deeper, and shallow lateral lobes serve as additional distinguishing marks.

Types.—Holotype and paratypes, U. S. National Museum.

Occurrence.—From the Kimmswick limestone of Missouri. The holotype is from the lower part of the Kimmswick, one-fourth mile north of New Hope, Missouri. The paratype is from the Goetz quarry, Glen Park, Missouri.

CYRTOCERINA FOERSTEI Flower, n. sp.
Plate 8, figures 1, 2, 6–8

Cross section with dorsum more narrowly rounded than venter, but not subangular; greatest shell width at center of cross section. Dorsal profile with a radius of curvature of 3 mm., in contrast to one of 4.5 mm. for the associated *C. kimmswickense*. The shell expands relatively rapidly. The holotype increases from 6 mm. and 7 mm. to 14 mm. and 19 mm. in a dorsal length of 20 mm. and a ventral length of 14 mm. Actual length of specimen 19 mm. The paratype increases from 4 and 6 mm. to 9 and 12 mm. in a dorsal length of 13 mm. and a ventral length of 7 mm.

The features of the phragmocone are largely hidden on both of the types. There is a suggestion that the camerae are more closely spaced in this form than in *C. kimmswickense*, and there is no clear indication of lateral lobes. The siphuncle is small at the base of the type and lies close to the concave venter.

Transverse growth lines, exceptionally well displayed on both of the types, indicate no trace of a hyponomic sinus.

Discussion.—This species, as noted under the discussion of *C. kimmswickense*, can be distinguished from it by the more rounded dorsum in cross section, the greater curvature and more rapid expansion of the shell. The sutures appear to be more closely spaced and to lack any trace of lateral lobes.

Types.—Holotype and paratype, U. S. National Museum.

Occurrence.—From the Kimmswick limestone of Missouri. The holotype is from the lower twelve feet of the Kimmswick at Pratt's quarry, three-fourths mile south of Elsberry, Missouri. The paratype is from the Goetz quarry, Glen Park, Missouri.

Genus MURRAYOCERAS Foerste

Genotype: *Orthoceras murrayi* Billings.

Shell orthoconic, depressed, the ventral side usually markedly flattened in cross section, sutures straight, transverse dorsally, with a ventral lobe of varying prominence, and also sometimes faint dorso-lateral lobes. Siphuncle tubular, relatively large, close to the venter. Septal necks short, orthochoanitic, connecting ring thin, homogeneous in structure. Siphuncle often filled with calcite, apparently inorganic; its exact nature is uncertain, but its presence is highly characteristic of the genus. Connecting rings may sometimes expand slightly within the camerae, simulating a slightly cyrtochoanitic siphuncle.

Discussion.—The extremely short necks and large ventral siphuncle suggest a relationship with *Baltoceras* rather than any of the Michelinoceratidae, in which the siphuncle is typically more removed from the venter and the septal necks are much longer and the siphuncle itself is smaller in diameter. The genus differs from *Baltoceras* primarily in the much more closely spaced septa, the ventral lobes of the sutures, the more marked flattening of the venter. Possibly the calcite which persists in the siphuncle will supply an additional difference if it later proves to represent an organic structure.

Only two described species have been placed in the genus (Foerste, 1926, p. 312; 1932, p. 120) *M. murrayi* (Billings) of the Black River of Ottawa and Lake Huron, and *M. carletonense* of the Black River of Ottawa. Though only one new form is described in the present work, *M. noveboracense* of the Amsterdam limestone of New York, it should be noted that *Murrayoceras* is a genus much larger and more significant in early Middle Ordovician faunas than has been previously recognized. The oldest species known to me (undescribed as yet) is from the basal Chazyan of the Champlain valley. The genus is not known as yet in the younger Chazyan faunas, but reappears as one of the dominant cephalopods in the Lowville limestone, both of western New York and of Ottawa. *Orthoceras multicameratum* Emmons is the New York form,

which was refigured and described as *Cameroceras? multicameratum* by Foerste (1932, p. 64, pl. 8, fig. 1–3, pl. 9, fig. 1). The Ottawa form is very closely similar, and probably conspecific. The genus appears again in the Carters limestone of Tennessee. It is present not only in the higher Black River (probably the Chaumont equivalent) at Ottawa, but also in the Chaumont of New York. I have not encountered the genus in the fauna at the Paquette Rapids of the Ottawa River, nor as yet in any undoubted lower Trenton beds.

Though the large ventral siphuncle which is so often occupied by calcite, causes *Murrayoceras* to resemble an endoceroid, abundant material has failed as yet to show the faintest trace of endocones. One thin section is remarkable in showing the calcite filling separated by a membrane from the connecting rings and septal necks. This structure, if real and organic (and I feel it requires further confirmation), is a structure unique in the cephalopods.

MURRAYOCERAS NOVEBORACENSE
Flower, n. sp.
Plate 6, figure 9

Type a portion of a phragmocone 65 mm. long, increasing in 50 mm. from 12 to 18 mm. in width at level of siphuncle. Corresponding shell height is unknown. Camerae closely spaced, six to seven in the length of an adoral shell width of 16 mm. Siphuncle composed of broad short segments, 3 mm. long, expanding from 4 to 4.7 mm. where the width of a camera is 15 mm. Section and position of siphuncle not clearly shown; ventral by all analogy.

Discussion.—The shell is more closely septate than either of the previously described species. From *M. multicameratum* Emmons it differs in the more closely spaced camerae, the broader siphuncle, and the slight expansion of the siphuncle in the camerae.

Occurrence.—In Amsterdam limestone, Jones' quarry, Chazy, New York.

Holotype.—New York State Museum.

Order ACTINOCERATIDA
Genus ORMOCERAS Stokes
ORMOCERAS CHAMPLAINENSE Flower, n. sp.
Plate 9, figures 10, 11

Shell essentially orthoconic, very slightly curved, presumably exogastrically, slightly depressed in cross section. The type displays a naturally weathered section of a very faintly curved shell increasing from 13 mm. to 17 mm. in the basal 40 mm., and to 37 mm. in the remaining 120 mm., at the point of the last septum. Orientation is somewhat uncertain. The siphuncle lies slightly closer to the convex side of the shell adapically, but closer to the concave side farther orad. It is assumed that the convex side represents the venter, since this condition is common in actinoceroids, and the siphuncle is commonly closer to the venter than to the dorsum, particularly in the early stages. If so, the sutures swing slightly forward on the ventral side and the septum is faintly asymmetric, its greatest depth and strongest curvature being located on the dorsal side. The sutures and septa are not preserved over the greater part of the shell. The segments of the siphuncle, however, show the spacing of the camerae, which are deep, two and a half to three occurring in a length equal to the adoral height of the shell. At a shell width of 17 mm. the siphuncle expands from 4.5 mm. to 6 mm. within the camera and the segment is 6 mm. long. The spheroidal segments and free septal necks are typical of *Ormoceras*. Deposits within the siphuncle show the typical wide transverse radial canals of the genus. Adapically the siphuncle is 4 mm. from the venter, 3 mm. in height, at the septal foramen, and 7 mm. from the dorsum. At a shell height of 22 mm. the siphuncle lies 12 mm. from the venter, 3 mm. across, and 7 mm. from the supposed dorsum.

Discussion.—The faint curvature, the large siphuncle which is nearly subcentral throughout but lies first slightly closer to the convex and then to the concave side of the shell, are distinctive features of this species, the only true *Ormoceras* thus far known to me in the Chazyan of the Champlain Valley. The type was originally a naturally weathered specimen (pl. 9, fig. 10). The specimen was broken through the middle originally, and the adapical part was sectioned further (pl. 9, fig. 11) to show the internal structure of the siphuncle, only the surface of which was shown on the original surface. The cross section indicates that the shell lies in a slightly oblique position in the rock, the venter lying to the left

of the center. If so, the siphuncle is closer to the venter throughout than indicated by the section alone, and probably the curvature of the shell was somewhat greater. There is no indication in the condition of the septa of any distortion of the shell.

Holotype.—New York State Museum.

Occurrence.—Labeled as lower Chazyan, Little Monty Bay, Chazy, New York. This locality is particularly notable for the abundance of cephalopods in upper Chazyan beds, associated with *Glaphurus pustulatus*. The lithology of the specimen does not indicate this association in the least, and in modern terminology it is uncertain whether this form came from actual lower Chazyan in the vicinity, or beds higher in the section which may be middle Chazyan. Middle Chazyan is suggested more strongly by the lithology.

Genus GONIOCERAS Hall

GONIOCERAS MINOR Flower, n. sp.

Plate 9, figure 3

This species is singular mainly in that it attained maturity at a very small size, as indicated by the gerontically crowded camerae at the adoral end of the holotype. The phragmocone of the holotype is 40 mm. long, retaining a median portion which increases from 25 to 30 mm. in width. The actual width is conjectural, as the lateral flanges are thin and incompletely preserved, unfortunately a common phenomenon in the genus. However it is evident that the lateral expansion of this shell is extremely gentle. The 13 lower camerae increase in depth from 2 mm. to 3 mm; the six adoral camerae are crowded, occupying together a total length of 7 mm. The sutures display broadly rounded rather shallow lobes on the venter, rising steeply to crests at the sides, which are narrowly rounded, subangular, and from there to the lateral margins the sutures slope apicad, becoming straight and making an angle of 40° with the horizontal plane. The venter is flat, the dorsum evidently much more convex, but more poorly preserved. The siphuncle is 3 mm. wide at the septal foramen, 2.4 mm. high, expanding within the segment to a width of 7 mm. and a height of 5 mm. The expanded portion, as indicated by the septal foramen, is 2 mm. from the ventral wall to the shell wall. The segments are not particularly clearly preserved, but typical of the genus, and visible on the weathered dorsal side.

Discussion.—The most striking feature of this species is its relatively small size, and the clear evidence of the attainment of maturity at this stage, by the adorally crowded camerae. The suture pattern on the venter is most closely similar to that of some of the species described from the Cape Calhoun series of northern Greenland, but these species are much larger and are rapidly expanding at commensurate portions. In *G. holtedahli* Troedsson the crests are more broadly and more uniformly rounded, and the sutures of the lateral flanges are more curved throughout, the convexity directed orad, and become nearly vertical at their juncture with the lateral margin of the shell. The degree of curvature of the sutures appears to vary somewhat from Troedsson's illustrations, but the rounding of the crests is quite uniform. *G. wulffi* is more similar to *G. minor* in the breadth of the ventral lobe and the relatively narrow flanges, but the lateral crests are again broadly rounded, and the sutures are convex orad over the flanges, and do not become straight laterally. In this respect, *G. angulatum* Troedsson is more similar to *G. minor*, but the sutures on the flanges are steeper, and the lobes are somewhat more narrowly rounded. *G. groenlandicum* is illustrated by shells showing some variation in suture pattern, but agrees with *G. minor* in the broad shallow median lobe rising steeply to the lateral crests, but the crests are more broadly rounded at their tops, the flanges are variable, being sometimes oblique and straight (Troedsson, pl. 54, fig. 1) and again curved throughout and becoming steeply inclined, very much as in *G. holtedahli* (pl. 65).

None of these species are comparable in size to *G. minor*, all being relatively gigantic. Indeed, the present evidence suggests that *Gonioceras* begins with a blunt apex, like other actinoceroids, but expanding even more rapidly laterally. Here the lateral flanges are poorly developed if at all. They reach fullest expression, however, in subsequent portions of the shell where the expansion is still rapid. In most species this is followed by another region, occupying the greater length of the shell, in which the sides diverge only gradually as they approach the aperture. (See Troedsson, 1926,

pl. 50, fig. 1.) Our form shows subparallel sides at a point at which, with comparable shell widths, all of the above northern species with somewhat similar suture patterns are still expanding laterally very rapidly.

Holotype.—Collection of G. Winston Sinclair.

Occurrence.—Long Point series, Newfoundland.

Genus LAMBEOCERAS Foerste

Though simpler than *Gonioceras*, with which it agrees closely in form and in siphuncle, *Lambeoceras* is in general a younger genus. Except in the north where the two genera may occur together, as in the section at Cape Calhoun, *Gonioceras* is clearly the older genus, ranging from the Chazyan into Black River and basal Trenton, while *Lambeoceras*, as previously known is a supposedly Richmondian genus. Species occur in the Richmond of Indiana, in several of the boreal associations, and two species, *L. confertum* Foerste and *L.* cf. *cultratum* occur in the Stewartville dolomite. At the present time it is possible to add to these species *L. montrealense*, which though relatively small is otherwise typical, from unquestionable Trenton beds, from the Terrebonne formation of Montreal, Quebec. For summary of species see Flower, 1946, p. 528.

LAMBEOCERAS MONTREALENSE
Flower, n. sp.
Plate 8, figures 21–23

Type and only known specimen, a living chamber with four attached camerae, with a maximum length of 72 mm., increasing laterally from 28 mm. to 44 mm. in a length of 65 mm.; with the corresponding heights 16 mm. at the base and an estimated 22 mm. adorally. Venter slightly convex, not flat, sides strongly rounded, not sharply angled as in most species, dorsum poorly preserved, but evidently considerably more arched in cross section than venter. Sutures with a broad rounded lobe occupying the entire dorsum 33 mm. wide and 7 mm. deep at the base of the living chamber. Lateral saddles rounded, not angulate, venter with a median lobe, slightly deeper than that on the dorsum, sutures becoming convex orad as they approach the sides, and faintly convex on the extreme lateral portion. The highest point of the lateral saddles is on the ventral face, and not on the extreme lateral angles.

The siphuncle, indicated at the base of the specimen, though rather obscure has a circular foramen 3 mm. in diameter, 5 mm. from the venter and 8 mm. from the dorsum.

The living chamber retains a part of the aperture, indicating a lateral length of 55 mm., in which the width increases from 33 mm. to an estimated 45 mm. The deep ventral lobe of the suture increases the total length of the living chamber by 10 mm.

Discussion.—This species is evidently quite rare, for only a single specimen has thus far been found. In general aspect the rather rapid rate of expansion, small size, and septation suggest *Rasmussenoceras* Foerste more closely than *Lambeoceras*, but the similarities are false, as shown by the large siphuncle which is well removed from the venter. In *Rasmussenoceras* the siphuncle is almost in contact with the venter, tubular, and tiny.

This species is distinctive in a number of features, the relatively rapid rate of expansion, the convex venter, the position of the siphuncle relatively far from the ventral wall, and the faint convexity of the sutures as they approach the lateral angles. The slight contraction of the last camera suggests that the type was approaching maturity. Strict comparison with other species is complicated by the fact that most species of *Lambeoceras* are not known from commensurate portions of the conch, but from fragments of a much greater width, and in which the sides are less rapidly diverging. Both of these features are unmistakably connected with later growth stages of *Lambeoceras*. Our form shows no indication in the adoral part of the living chamber of a reduction in the rate of lateral expansion, and is of a size which might reasonably be expected to show this feature, by analogy with other species, if it were developed in this form.

As the only species of *Lambeoceras* which is definitely as old as the late Trenton, this form may be expected to show some primitive features. The slight lateral convexity of the saddles on the extreme sides of the ventral face may be a feature which is traceable back to the older and possibly ancestral genus *Gonioceras*. Although structurally more complex, the greater age of *Gonioceras* indicates that it must be ances-

tral to *Lambeoceras* if, as seems evident from other similarities, the two genera are genetically related.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—Terrebonne formation, Isle Jesus, Montreal, Quebec.

Order MICHELINOCERATIDA
Genus KIONOCERAS Hyatt

Genotype: *Orthoceras doricum* Barrande, Middle Silurian, Bohemia.

Kionoceras HYATT, 1884, Boston Soc. Nat. Hist., Proc., vol. 22, p. 275.—NEWELL, 1888, ibid., vol. 23, p. 469.—HYATT, 1900, Cephalopoda, in Zittel-Eastman Textbook Paleont., vol. 1, 1st ed., p. 519. Reprinted, later editions.—CLARKE & RUEDEMANN, 1903, New York State Museum, Mem. 5, p. 82.—GRABAU & SHIMER, 1910, North American Index Fossils, vol. 2, p. 61.—FOERSTE, 1927, Denison Univ. Bull., Sci. Lab., Jour., vol. 22, p. 40.—FOERSTE, 1928, ibid., vol. 23, p. 285.—FOERSTE, 1932, ibid., p. 91.—TROEDSSON, 1932, Lunds Universitets Arsskr., N. F., Avd. 2, Bd. 28, nr. 6, p. 9.

Kionoceras was originally erected for orthoceracones characterized by dominant longitudinal markings on the surface of the shell. Such forms were believed to all have tubular siphuncles. It was placed, with *Spyroceras* and *Thoracoceras*, in the family Kionoceratidae (Hyatt, 1900), a family erected for ornamented orthocones with dominant longitudinal markings on the shell surface. A great many species have been placed in *Kionoceras*, showing much variation in ornament. Usually no attempt was made to investigate the interior of the shell, a fact which became somewhat embarrassing when it was found that some cyrtochoanitic cephalopods developed this type of ornament also. Instead, when the group became large and unwieldy as a genus, attempts were made to subdivide it on the basis of the surface features of the shell.

Grabau and Shimer (1910) separated *Protokionoceras* based upon the Middle Silurian *Orthoceras medullare* Hall. The genus was defined as possessing "fine longitudinal striae" in contrast to the more elevated ribs of a true *Kionoceras*, but actually the genotype shows a pattern of fine raised lirae, transverse and longitudinal, which cross, forming a cancellate surface pattern. Subsequent use of the genus has not been altogether uniform, being sometimes employed for forms with fine longitudinal markings, as defined in the original description, and sometimes for forms with cancellate surfaces. This is, in the light of the condition of the genotype, the proper usage. This left in *Kionoceras* not only species with prominent ribs, sometimes with finer longitudinal and even also transverse markings, forming a fine surface ornament which might be cancellate, though ribs were also present, distinguishing them from *Protokionoceras*, but also forms with only relatively fine longitudinal markings on the surface. Indeed it would seem that there is not a really sharp distinction between ribbed and fluted species on one hand, and those in which the ribs are reduced to fine longitudinal lirae and striae, as all gradations between the two extremes can be found, particularly in the Middle Silurian, where kionoceroid shells reach their peak of abundance and greatest variability. However, the apparent difficulty was eliminated by Foerste (1928, p. 263) who erected *Polygrammoceras* for shells which were longitudinally striated, ribbed or barred, but not fluted. The genotype, *P. twenhofeli* Foerste, of the Ellis Bay formation of Anticosti, adds to the difficulty of the situation because its siphuncle is expanded within the camerae, as much so as in some of the Sactoceratidae, and it is not certain therefore whether *Polygrammoceras* is a stock of the orthochoanitic Michelinoceratidae, of the Sactoceratidae or possibly belongs to some other stock, such as the Stereoplasmoceratidae. To add to the complexity, usage on the basis of surface features alone has not been consistent. Cancellate surfaces are found in species included in *Polygrammoceras*, as *P. chicottense*, and forms without transverse markings, as *Protokionoceras anticostiense*, have been included in that genus. An additional problem is presented by *Polygrammoceras chicottense* which apparently has two siphuncles, one nummuloidal, the other tubular. Foerste suggested that the one, apparently the large tubular siphuncle, was the work of a commensal organism. This is possible, but not probable, for the same structure is found again in the Middle Silurian of England, where it occurs in an orthocone not known to possess longitudinal or cancellate surface markings, *Orthoceras bisiphonatum* Sowerby, of the lower Llandovery and lower Wool-

hope formations. On the basis of the second siphuncle, the genus *Tretoceras* Salter (1858) was erected for this species. Salter (1859) placed a second species in this genus, *Orthoceras semipartitum* Sowerby (Siluria, 2nd ed., pl. 34, fig. 5, 1859) but did not state his reasons for doing so. Barrande (1874, 1877, p. 1415) described an additional form, *T. parvulum* a small shell having a marginal cylindrical tube in addition to the nummuloidal siphuncle. In this species the tube appears from Barrande's drawings to extend orad of the phragmocone slightly into the living chamber. It may therefore be a commensal structure, but that it may be some completely bizarre and new modification of the shell is not impossible. Certainly the presence of these four species, all in the Middle Silurian, and the absence of the anomalous "double siphuncle" in any except these few species, otherwise quite similar structurally and allied stratigraphically, indicates that it is a natural structure, and that *Tretoceras* is probably a valid genus. However, if this is a real shell structure, as my own examination of *P. twenhofeli* indicates, the structure is so anomalous that it is deserving of recognition as a family or even a higher group.

Foerste (1928) defined *Protokionoceras* as possessing vertical striations between ribs, but actually the genotype lacks true ribs, and his later usage of the genus conforms with this fact. Admittedly, treatment of the entire group has not been very satisfactory because anomalies of internal structure have not been widely taken into consideration.

Striacoceras Flower (1936) was erected for Devonian forms with subtubular siphuncles, in which the early portions were cancellate as in *Protokionoceras*, while the later stages lost the longitudinal markings and retained only a surface similar to that for which the genus *Geisonocerina* was made by Foerste. There can be little doubt but that this stock, composed of a small group of Middle and Upper Devonian species, trace their ancestry back to orthochoanitic Silurian forms with cancellate surfaces which have been placed in *Protokionoceras*. However, I am not conviced that the genotype of *Protokionoceras* is demonstrably orthochoanitic. Clearly, delimitation of these genera will require careful restudy with due regard to internal as well as external features.

Shells of the aspect of *Kionoceras* in the broad sense have been known to have cyrtochoanitic siphuncles, and some taxonomic provisions have already been made for this situation. *Troedssonoceras* Foerste was erected for such shells. This genus has subsequently been found to be an actinoceroid, closely related to *Deiroceras* (Flower, 1939, 1946). The genotype is *Orthoceras turbidum* Hall and Whitfield (1879). Shimizu and Obata based *Striaticeras* upon *Sactoceras*(?) *striatum* Troedsson, and *Ohioceras* upon *Sactoceras* (?) *lineatum* even placing the genera in different families. Both are fluted shells with expanded siphuncles; one is somewhat broader than the other but, especially as such differences may be due to one section which penetrates the middle of the siphuncle while the other might be slightly off center, are inadequate for generic let alone family differences. Shimizu and Obata have, however, been consistent. They have used genera for families, species for genera; but what they use for species I have as yet been unable to discover (Flower 1939, 1939A, p. 167, 1946, p. 536). Teichert (1934, p. 40) has restudied the siphuncles of these arctic species, and has shown that they are not actinoceroids. I have tentatively placed the genus, with some other Ordovician cyrtochoanitic types, in the family Stereoplasmoceratidae (Flower and Kummel, 1950), but further study is desirable and may require emendation of this tentative conclusion.

One other kionoceroid with an anomalous interior remains to be mentioned. *Polygrammoceras endoceroides* Troedsson of the *Orthoceras* limestone of Sweden, has a narrow siphuncle apparently containing endocones. While thin section study is eminently desirable for this species, it is quite evident that it is structurally distinct enough from other kionoceroids, and deserving of a new generic grouping. Kobayashi (1935) based the genus *Troedssonella* upon this species. It is, however, extremely dubious whether this form is an ellipochoanitic endoceroid as Kobayashi believes; rather, it seems equally probable that the endocones have developed independently in longitudinally marked Ordovician Michelinoceratidae. I have undescribed cases of similar structure

from the Silurian of Indiana. It is already known that endocones are not an essential endoceroid feature. Opposed to the endoceroid nature of this form is the subcentral position and small size of the siphuncle and the remarkably deep camerae. These are not necessarily fundamental, but they are, I think indicative.

In the Middle Silurian of Indiana a species which is externally a *Protokionoceras* was found to have the internal structure of a *Virgoceras*. This species I described as *Virgoceras cancellatum* (Flower, 1939, p. 162, pl. 8, fig. 14).

Since it is demonstrable that the surface features of the kionoceroids have developed at least twice in cyrtochoanitic cephalopods, one group being definite actinoceroids, the other definitely not actinoceroids, and tentatively assigned to the Stereoplasmoceratidae, it is equally probable that differences in internal structure among orthochoanitic forms may indicate that in this group also the longitudinal ornament types considered characteristic of *Kionoceras*, *Protokionoceras* and *Polygrammoceras*, have little taxonomic significance. The structures already known support this view, but enough data have not been accumulated on internal structures in orthochoanitic forms to permit proper placing of the known species in any tenable arrangement.

While at present a solution to this problem cannot be presented, a contribution toward it can be made. The Ordovician species of *Kionoceras* in America constitute a group characterized in general by small size, slender form, and an ornamentation which is relatively simple. The siphuncles are relatively large and perfectly tubular. These species contrast strongly with the kionoceroids of the Silurian, which in contrast, are more rapidly expanding, relatively giants, often attaining two feet or even more in length, and the siphuncles are supplied with more elaborate internal structures, generally annulosiphonate. The known features are not adequate to prove that Ordovician *Kionoceras* should be separated from those of the Silurian, but the differences are sufficient to suggest that it is perfectly possible that the two stocks may be completely unrelated, and that the Ordovician types did not persist into the Silurian, but instead their surface patterns were duplicated in another genetic stock, probably represented in the Ordovician by smooth-shelled types.

Representatives of the Ordovician group of species are mainly American, with the addition of two forms, not quite typical, from the *Orthoceras* limestone of Sweden. The known species appear in the middle Chazyan, persist through Mohawkian faunas, and are thus far known in the Upper Ordovician only from a few species from the Maquoketa shale of Iowa.

The reputed occurrence of kionoceroids in the Canadian rests upon *Kionoceras laqueatum* (Hall). This species is redescribed and reillustrated in the present work. There is nothing in records, lithology or structure of the one and only known specimen of this species to justify attributing it to the Canadian. It is much more probably from the Black River or lower Trenton.

The oldest species are those from the middle and upper Chazyan of the Champlain Valley. I have a few fragments from the *Maclurites* ledges of the middle Chazyan on the western edge of Chazy village, New York. They are too weathered for specific determination, but there is no reason to believe that they are not conspecific with the beautifully preserved material from the lower Valcour limestone, which occurs in the dove grey massive beds with a large cephalopod and trilobite fauna, which Raymond (1906) referred to as the *Glaphurus pustulatus* assemblage. Here four species can be recognized, except of course by those who insist that there may be only one species of a genus in a population. I shall leave to them the problem of reconciling the obvious differences among *K. valcourense*, *K. infrequens*, *K. polyplicatum* and *K. erraticum*. Ruedemann (1906, pl. 16, fig. 7) attributed portions of these species to early stages of "*Spyroceras*" *clintoni* (Miller), a species which is probably referable to *Gorbyoceras*. In that species annuli persist to a much earlier stage, actually commensurate with some of these kionoceroid specimens, and the siphuncle in such stages is not tubular, but still rapidly expanded within the camerae.

No members of this group have been described from beds of Lowville age. I have collected a specimen, too incomplete to merit description, from the Lowville of Ottawa.

Fragmentary representatives of the stock occur in the Carters limestone of the central basin of Tennessee, which carries an association of orthoceracones of definite Lowville aspect, though the beds are regarded, and may very well be, younger than the true Lowville.

In the high Black River and lower Trenton several representatives of the stock have been described. *K. huronense* Foerste (1932, p. 93, pl. 22, fig. 6) and *K. multistriatum* Foerste (1932, p. 94, pl. 22, fig. 7) represent the group from the Chaumont (and, according to Kay, possibly lower Trenton), of St. Joseph Island, Lake Huron. *K. allumettense* Foerste (1932, p. 93, pl. 22, fig. 5), and *K. paquettense* Foerste (1932, p. 92, pl. 37, fig. 2) are from the silicified fossil assemblage of the Paquette Rapids of the Ottawa River. Though evidently slightly younger than the Chaumont, the equivalence of these beds to the Rockland and their assignment to the Trenton, proposed by Kay, does not seem to be adequately demonstrated.

K. kentlandense Kindle and Breger (1921, p. 275, pl. 35, fig. 1) brings the same stock to light in beds, probably of Platteville age, in the cryptovolcanic structure at Kentland, Indiana. The form has not yet been reported from the Platteville formation of the upper Mississippi Valley, though it may be that, as such a small form, it has been overlooked, I have a form from the overlying Decorah shales, described below as *K. decorahense.*

The Trenton of New York has yielded *K.* sp. (Foerste, 1921, p. 276, pl. 35, fig. 2) which is listed as "lower Trenton," from Middleville, N. Y. These are probably beds currently correlated with the Kirkfield, which apparently yielded at one time a small lens replete with cephalopods, which I have never been able to relocate or duplicate. *K. trentonense* Foerste (1921, p. 275, pl. 35, fig. 1) occurs in the Poland member of the Sherman Fall limestone. I have found fragments of similar forms again in the Sherman Fall equivalent of the Montmorency River at Quebec.

K. holtedahli Foerste (1921, p. 273) is from the arctic (not antarctic) of Bear Island, near Spitzbergen. Troedsson (1932) has described and figured a number of species assigned to *Kionoceras*, *Protokionoceras* and *Polygrammoceras* from the *Orthoceras* limestone of Sweden. Of these, *K. acutum* (Angelin) differs from our forms in a somewhat larger size, a slightly expanded siphuncle, and a relatively rapid rate of shell expansion. It is probably not closely related to our forms. *K. timidum* Troedsson, though relatively large, is typical in its slender form, deep camerae and ornament. Perhaps such forms as *Polygrammoceras lineatum* (Hisinger) *P. densistriatum* Troedsson and *P. delicatulum* Troedsson belong to this stock, possibly stemming from *Kionoceras polyplicatum* of the Chazyan. They retain a relatively slender form, deep camerae, and large tubular siphuncles.

Richmondian beds generally lack members of this stock. No species are known from the doubtfully Richmondian boreal faunas, though of course they may have escaped notice as tiny species in a fauna so largely devoted to gigantic and bizarre types. More significant is the absence of any such types in the Cincinnatian, either Covington or Richmond, of New York, Ontario, Quebec, or the Cincinnati arch. The only Upper Ordovician forms which are possibly assigned to this group are three species de-

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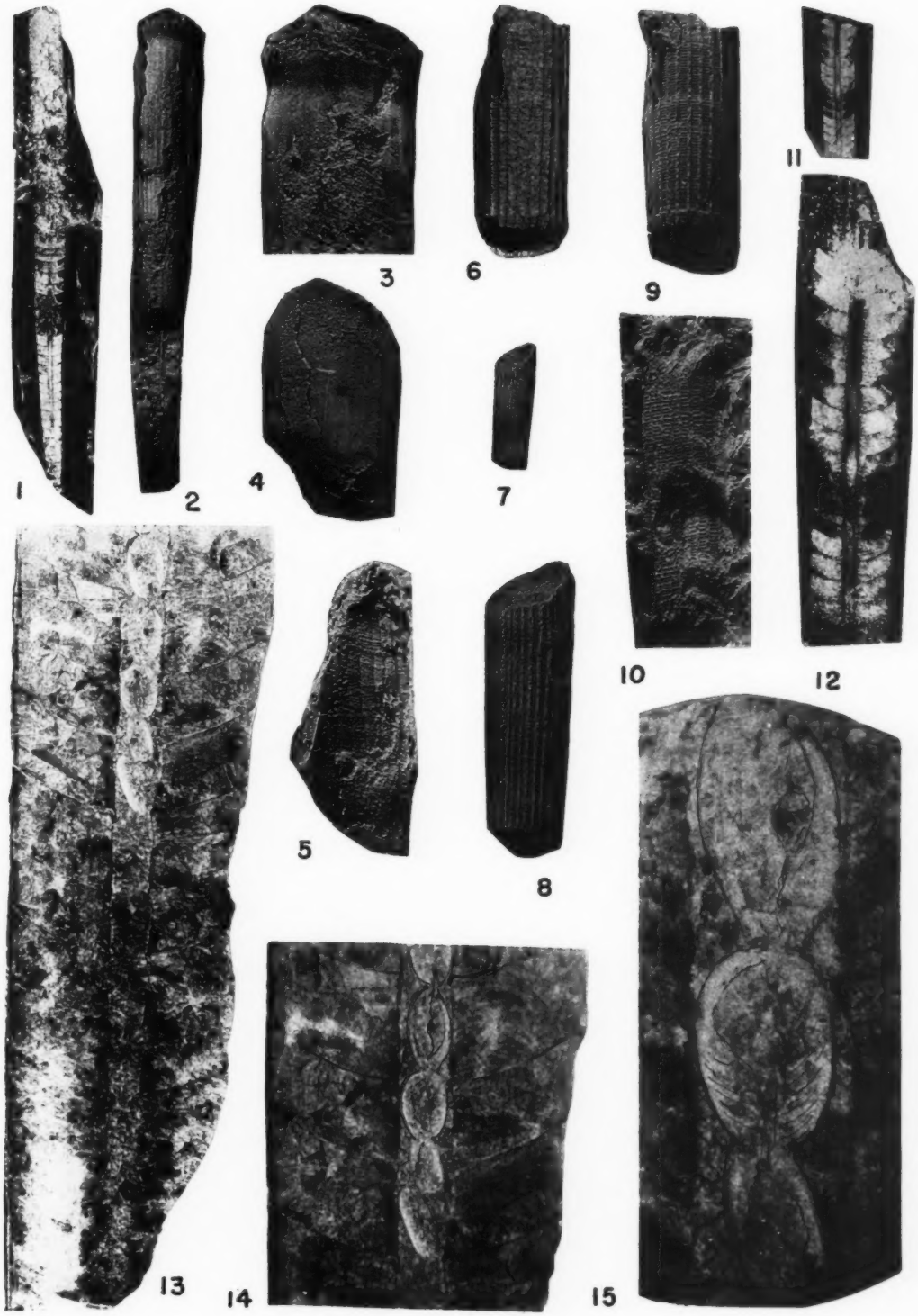
EXPLANATION OF PLATE 5

FIGS. *1–5*—*Kionoceras valcourense* Flower, n. sp. (*1*) paratype, section ×1; (*2*) holotype, ×1; (*3*) adoral end of same specimen enlarged, showing irregularity of transverse striae in gerontic stage. (*4*) portion of a paratype, showing more regular normal ephebic transverse markings ×2½. (*5*) paratype, external mold, showing ribs and fine markings. (p. 38)

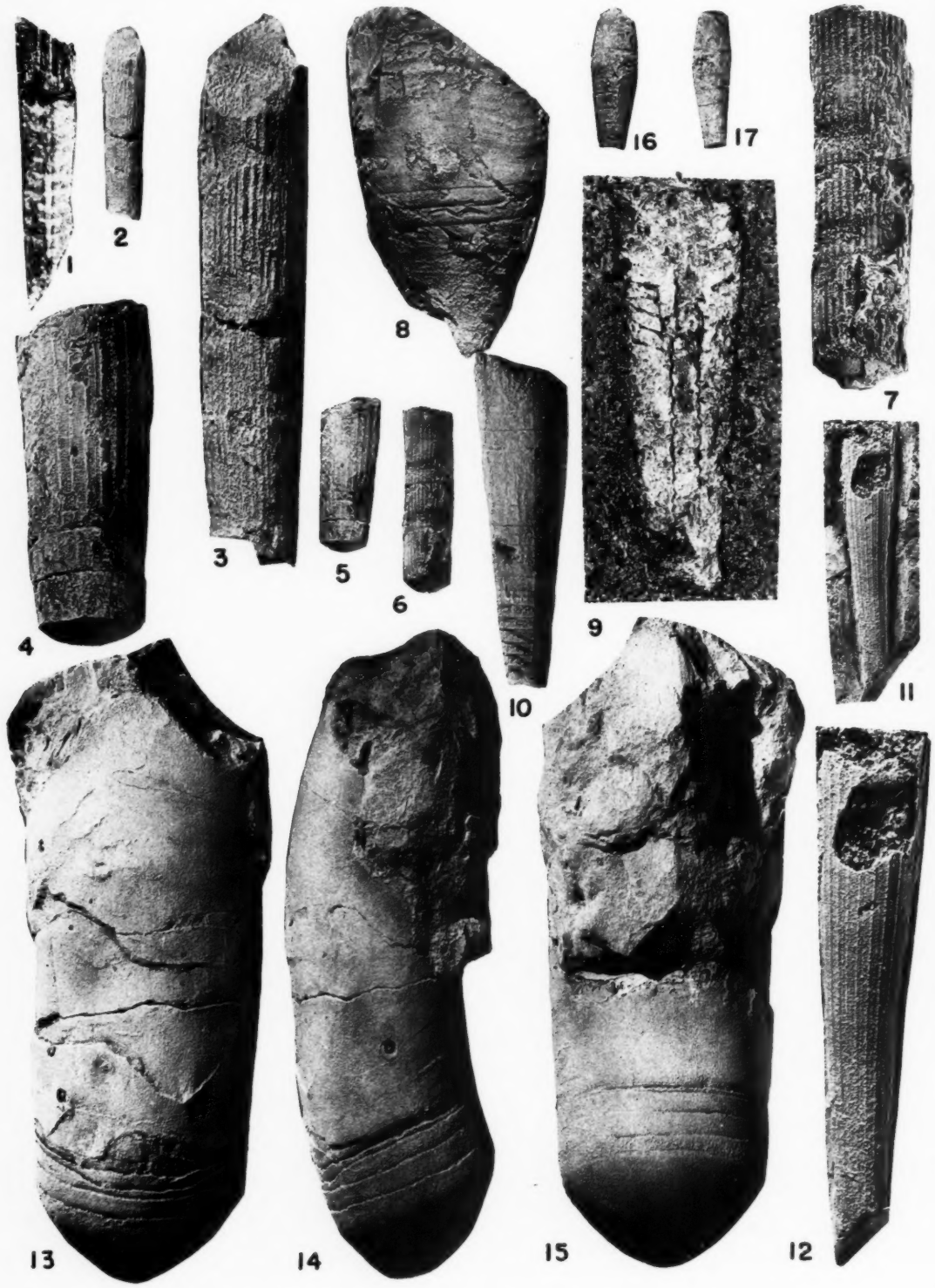
6–12—*Kionoceras erraticum* Flower, n. sp. (*6*) holotype, ×2½; (*7–8*), paratype, ×1 and ×2½. (*9*) paratype, showing unusually broad ribs. (*10*) crushed specimen showing clear transverse markings. (*11–12*) vertical section ×1 and ×2½. (p. 40)

13–15—Three enlargements of a single thin section, *Kionoceras* cf. *erraticum*, showing ovoid bodies within siphuncle. (*13*), ×10, showing greater part of the specimen; (*14*), adoral part showing irregularity of bodies at apical end of series; (*15*), ×45, is a further enlargement showing nature of three bodies in detail.

All specimens are from the Valcour limestone, west of Little Monty Bay, southeast of Chazy, New York.



Flower, Ordovician eastern North American cephalopods



Flower, Ordovician eastern North American cephalopods

scribed by Foerste from the Maquoketa shale of Iowa, which I regard as definitely Richmondian. These are *K. thomasi* Foerste (1935, p. 242, pl. 29, fig. 4), *K. postvillense* Foerste (1935, p. 243, pl. 28, figs. 2–3; pl. 29, fig. 5) and *K. tenuitectum* Foerste (1935, p. 244, pl. 29, fig. 2).

Morphologically, three subdivisions are readily recognized within this species group. First, there can be separated those species in which the rate of expansion is moderate, in contrast to those shells in which it is so very small that small portions may appear essentially tubular. Moderately expanding forms are *K. laqueatum*, *K. paquettense*, and *K. decorahense*. Among the slender forms we may differentiate those with shallow camerae, with three to five camerae in a length equal to the adoral diameter of the shell, a feature found, in general, also in the more rapidly expanding species noted above. In this group fall *K. erraticum*, *K. multistriatum* and *K. tenuitectum*. In contrast, other species have very deep camerae, the camera being often as deep as the width of the shell, or very nearly so. In this group fall *K. valcourense*, *K. infrequens*, *K. polyplicatum* of the Chazyan, and the younger *K. huronense*, *K. kentlandense*, *K. postvillense* and *K. thomasi*. *K. trentonense*, with rather shallow camerae, is tubular in the early stages, later becoming more rapidly expanding. The ontogeny and the stratigraphic distribution suggest that tubular deeply camerate forms are primitive, from these developed forms with shallower camerae, and finally forms with more rapid shell expansion.

Cameral deposits are indicated, but not always clearly shown in the Chazyan members of this group. They are indicated, though only in certain camerae, as shown in plate 5, figure 1 and in plate 5, figures 11–12. Apparently in some camerae they take on the hue and texture of the calcite which fills the remaining space of the camerae, and thus tend to vanish with recrystallization. However, in other camerae, perhaps as a result of induration, they retain a darker color than the inorganic calcite and are thus preserved. Molds of the cameral deposits, which are mural, are seen in the holotype of *Kionoceras decorahense*.

The tubular siphuncles are in general empty. However, one specimen shows within the siphuncle a series of structures so singular that, after hoping for additional material for ten years, I finally publish them, though additional specimens must be obtained before a satisfactory interpretation can be reached as to their nature and function. This specimen, shown on plate 5, figures 13–15, is remarkable in containing within the siphuncle a series of oval bodies. The entire section, illustrated × 10 in plate 5, figure 13, shows a portion of a phragmocone occupied by calcite. Only faint traces of cameral deposits persist, owing to extensive recrystalization. The tubular wall of the siphuncle is clearly shown, however, with orthochoanitic septal necks and thin connecting rings, both quite clearly defined, even under higher magnification. The adoral part of this specimen shows a series of five and part of a sixth elongate oval body within the siphuncle. The apical two are

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EXPLANATION OF PLATE 6

FIGS. *1–3*—*Kionoceras erraticum* Flower, n. sp. (*1*) paratype ×1; (*2*) paratype ×1; (*3*) same specimen ×2½. (p. 40)

4, 5—*Kionoceras infrequens* Flower, n. sp. Holotype, ×2½ and ×1. (p. 39)

6, 7—*Kionoceras polyplicatum* Flower, n. sp. Holotype, ×1 and ×2½. Valcour limestone, Little Monty Bay. (p. 40)

8—*Diestoceras sycon* Flower, n. sp. Holotype, Museum of Comparative Zoölogy, no. 5025. Black River limestone, Poland, New York. (p. 55)

9—*Murrayoceras noveboracense* Flower, n. sp. Amsterdam limestone, Jones quarry, Chazy, New York. New York State Museum. Natural section, horizontal. (p. 30)

10—*Kionoceras decorahense* Flower, n. sp. Holotype, ×1. Decorah shale, Decorah, Iowa. (p. 42)

11, 12—*Kionoceras laqueatum* (Hall) Holotype, ×1 and ×2. Origin unknown; from New York and probably from the Black River limestone. (p. 41)

13–15—*Choanoceras imitans* Flower, n. sp. Holotype ×1, (*13*) ventral (*14*) lateral and (*15*) dorsal views. Platteville dolomite, northern Illinois. Museum of Comparative Zoölogy, no. 2145. (p. 46)

16, 17—*Whitfieldoceras gracile* Flower, n. sp. Holotype, ×1, ventral and lateral views. Sherman Fall limestone, Lakefield, near Peterboro, Ontario. (p. 43)

displaced and the whole series gives the impression of structures which have been crowded together. The bodies have a sharply defined dark outer wall, darker and slightly thicker and more regular than the connecting ring itself. Lying just inside this wall there is an area of clear light calcite, which merges toward the center into darker calcite similar to that filling the remainder of the siphuncle. In most parts of these bodies any original fine structure, other than the thin definite outer wall, has been lost or obscured by recrystallization of the calcite. Close examination, however, yields two sorts of structure, first faint traces of radial lamellae in the zone of white calcite, and second, faint curved lines. These are clearly seen only in the third of the bodies from the apex. Here the lines suggest that the light calcite was built up layer by layer, starting first at the apical end, and gradually growing forward. At the very apex, however, the material is interrupted by a canal, definite, though with irregular walls. This canal seems to supply a connection between the cavity within one body to that of the next. Plate 5, figure 15 is retouched to increase the clarity of these structures. Under high magnification the clarity of the curved lines or lamellae is greatly increased. Other of the oval bodies show only isolated traces of the lamellae. However, there is indication that we are dealing here with a series of connected oval bodies, each consisting of a wall, thin and definite, within which other material was deposited, mainly at the apical end of each body, but leaving a cavity in the center of each, and the series of cavities were connected by tubes which are narrow where they pass from one body to the next, but enlarge gradually within each body to merge with the cavities.

The irregular position of these bodies and their rarity suggest at once that they are foreign structures washed into the cephalopod siphuncle. They are clearly organic, from their regularity of form and structure, and after some ten years of desultory inspection, in which I inflicted them on various of the more gullible of my friends and visitors, no good suggestions have been forthcoming as to what sort of organism, other than the cephalopod, may have produced them. Further, the fact that they appear in a part of the siphuncle occupied by inorganic calcite, and free from matrix, opposes the obvious interpretation of these structures as foreign bodies. It seems likely, therefore, that these bodies are some part of the cephalopod or, which seems less possible, some organism which invaded it during life. The bodies are completely different from anything else observed in cephalopod siphuncles in my experience. They are surely somewhat displaced, and may represent some structure of the siphonal tissues which is rarely preserved, and then only under the most exceptional conditions. The only structures even remotely resembling these are those figured by Teichert (1933, p. 211, fig. 49, pl. 13, fig. 45) in a siphuncle of a small orthocone from the Canajoharie shale of Florida, New York. Here the shell is extensively replaced by pyrite, and the exact interpretation of the structures is therefore made even more uncertain. However, the resemblance is, at the best, superficial, and it is probable that the actual structures are quite different. Any further suggestions as to the nature of these bodies will be gladly welcomed, providing they are sensible.

KIONOCERAS VALCOURENSE Flower, n. sp.
Plate 5, figures 1–5

Shell orthoconic, slender, circular in section. The holotype, consisting of the greater part of a mature individual (pl. 5, fig. 2) increases in diameter from 4 mm. to 8 mm. in the 30 mm. of the phragmocone. The living chamber increases from 8 to 9.5 mm. in the basal 25 mm., beyond which the exterior of the shell is contracted, expanding again at the aperture, which, 28 mm. beyond the base, resumes the diameter of 9.5 mm.

Sutures are straight and transverse. Septa moderate in depth apically, but more deeply curved adorally, being 1 mm. in depth at a shell diameter of 6 mm. Curvature becomes eccentric vertically, the greatest depth of the septum lying ventrad of the center of the shell. Camerae relatively deep. Adapically, at a shell diameter of 5 mm., slightly less than three camerae occupy a length equal to the adoral shell diameter. The number decreases to two at a diameter of 5 mm., a proportion which continues up to the last two camerae which are only slightly shorter than the others. The siphuncle lies 4.5 mm. from the dorsum and

3.5 mm. from the venter in the later portion of the shell, and is very slightly eccentric from the earliest observed stage. It is tubular, and no organic deposits have been noted. Mural deposits have been noted in the camerae, but are rarely clearly preserved.

Surface markings show some slight variation in individuals attributed to the species. Longitudinal ridges are low, the interspaces broader and flat. The circumference of the living chamber of the holotype bears 36 such lirae. Finer surface markings consist of very minute transverse striae, ten to fifteen in the length of 1 mm., crossing the longitudinal ridges. Some, at least, are discontinuous around the circumference of the shell. Striae are stronger and slightly more widely spaced over the region of the preoral constriction of the living chamber than elsewhere. Some early portions of the shell which have been observed in other individuals assigned to the species have failed to show any fine sculpture whatsoever. Others have revealed the striae only obscurely, and in some individuals there is doubt as to whether they are not slightly elevated ridges in the early part of the shell. One individual, part of a mature living chamber judging by its size alone, shows in addition to the fine transverse markings, exceedingly minute and faint longitudinal markings which supply a background for the transverse ornament. It is not impossible that these several variations in surface markings may eventually prove to belong to representatives of other species, as yet otherwise unknown.

Discussion.—This species is characterized by low narrow longitudinal ridges with broad flat interspaces. The fine transverse markings crossing the ridges will serve to distinguish this form, wherever good surfaces are displayed.

Portions of this and related species described below were formerly considered as representing early stages of "*Spyroceras*" *clintoni* (Miller) of the Chazyan (Ruedemann, 1906, p. 446, pl. 16, fig. 7). However Ruedemann noted in assigning the fragments to this species that no specimens had been observed bridging the gap from the non-annulated to the annulated condition. The present study shows that these kionoceroids are neither specifically nor generically related to *S. clintoni*. The fortunate discovery of a complete living chamber in *K. valcourense* shows that maturity is attained without the development of any annulations. Further, early stages of *S. clintoni* have been found retaining annuli at as small a shell diameter as 6 mm. The discordance between the two groups is further emphasized by the siphuncles, that of *Kionoceras* being tubular, while even at the earliest stage observed, the siphuncle of *S. clintoni* is considerably expanded within the camerae.

Types.—Holotype and paratypes, collection of the writer.

Occurrence.—From the *Glaphurus pustulatus* fauna, Valcour limestone, Little Monty Bay, southeast of Chazy, New York. This locality, from which Ruedemann (1906) and the writer obtained much fine material, and long established in the literature under this name, lies on the north side of a road now indicated as Shelburne Lane, passing east from the main Plattsburg-Chazy road east to Little Monty Bay, which has been renamed Trombley's Bay on the more recent topographic maps.

KIONOCERAS INFREQUENS Flower, n. sp.
Plate 6, figures 4, 5

Holotype a portion of a shell 22 mm. long, expanding from 6 to 9 mm. Two camerae are preserved, each 3 mm. in depth, so that approximately two camerae occupy a length equal to the adoral shell diameter. Sutures straight and transverse; septum shallow, siphuncle 2 mm. from venter and 4 mm. from the dorsum, a slightly greater eccentricity than that of *K. valcourense*.

Surface with narrow longitudinal ridges, slightly more prominent than in *K. valcourense;* about 30 of these occupy the circumference of the shell. Interspaces with fine transverse markings, not crossing the ridges, apparently faintly elevated lirae rather than striae. Eight occur in the length of 1 mm.

Discussion.—This form, though known from only a few specimens, none complete, is similar to *K. valcourense*, but departs from its proportions in almost every feature, the more eccentric siphuncle, the less deeply curved septa, the slightly more rapidly expanding shell. The spacing of the longitudinal ridges is about the same in the two

species, but the finer surface markings are more widely spaced, and the surface is quite different in appearance.

Holotype.—Collection of the writer.

Occurrence.—Valcour limestone, associated with the preceding, near Little Monty Bay.

KIONOCERAS ERRATICUM Flower, n. sp.
Plate 5, figures 6–12; plate 6, figures 1–3

Shell slender as in *K. valcourense*, sutures straight, transverse, septa shallow, camerae relatively short, four normally occurring in a length equal to the adoral shell diameter. Siphuncle very slightly eccentric, tubular. Camerae with mural deposits. A thin section which appears to belong to this species bears peculiar ovoid bodies within the siphuncle illustrated on plate 5, figures 13–15, and already described under the discussion of the genus.

Shell surface with distinctive ornament, with longitudinal ridges relatively broad, slightly flattened on their crests. Twenty-four to 32 occur in the circumference of the shell; showing variation from one growth stage to another, the number increasing with the diameter of the shell. New ridges appear in interspaces, and are obscure at their beginning. Between the ridges are transverse lirae, raised, thread-like, separated by relatively broad interspaces, occurring five to eight in a length of 1 mm. They never cross the longitudinal ridges.

Representatives of this species are all small shells, the greatest shell diameter observed being 7 mm. One such specimen shows traces of a slight adoral constriction of the shell, indicative of a mature condition similar to that shown in better material of *K. valcourense*. However, another specimen of the same diameter lacks this constriction, suggesting some variation in the size of the shell at maturity.

Discussion.—This species, the most abundant in the Valcour limestone, is readily distinguished from *K. valcourense* by the much shallowed condition of the camerae, and by the ornament in which longitudinal ridges are broader, slightly flattened, and not crossed by the relatively strong transverse markings, which are here lirae rather than striae. Indeed, the prominent strong longitudinal markings are a distinctive feature, by which this species can be readily distinguished from all previously described forms. It is characteristic of this species that the longitudinal ridges are more crowded on one side of the shell than on the other. Foerste (1932, p. 92) has noted the same phenomenon in *K. paquettense*, of the Black River limestone of the Paquette Rapids, where crowded lirae are reported on the dorsal side of the shell. In material of the present species, in those specimens showing crowding of the lirae on one side (which are rare, as ordinarily the surface markings are not clearly displayed around the entire circumference of the shell, a preservation phenomenon, also complicated by the vexations of extraction of good surfaces), it is not clearly demonstrable whether the crowding occurs on the dorsum. This interpretation seems to be somewhat of an assumption in relation to the Paquette Rapids species also.

Types.—Collection of the writer.

Occurrence.—Valcour limestone, from Little Monty Bay, in association with the preceding forms.

KIONOCERAS POLYPLICATUM Flower, n. sp.
Plate 6, figures 6–7; plate 9, figures 1, 4

Shell small, circular, expanding from 4.5 to 5.5 mm. in 15 mm. in the early part, the rate of expansion decreasing slightly adorally. A portion of a living chamber, recording the greatest dimensions observed, increases from 6.4 to 6.9 mm. in a length of 15 mm. Sutures straight and transverse. Camerae occur two and a half in a length equal to the adoral shell diameter, up to a diameter of 6 mm., beyond which the camerae are somewhat shortened (pl. 9, fig. 1). Septa shallow, siphuncle scarcely eccentric at base of living chamber, and central in the early portion.

Exterior with a series of numerous subequal low ribs, about 40 in the circumference of the shell; they are low, rounded, and contrast sharply with the more elevated flattened ribs of *K. erraticum*, while they are more prominent and more closely spaced than those of *K. valcourense* or *K. infrequens*. Transverse markings are present, but are obscure in all specimens thus far encountered, apparently more numerous than those of *K. erraticum*.

Discussion.—This is apparently a small species, the known specimens indicating

maturity of the shell at a diameter of 6 mm. The early part of the conch appears to be somewhat more rapidly expanding than the later portion. The deep camerae suggest *K. valcourense* and *K. infrequens*, which are markedly different in the narrower and much more sparsely distributed longitudinal ridges of the shell.

K. trentonense Foerste, which has about the same number of vertical ribs, shows a marked alternation between fine and coarse ribs which are completely lacking in the present species. Further, that species attains a greater size, attaining adorally, as shown by my own material, unpublished, and adorally attains a somewhat more rapid rate of shell expansion. The early portion, however, is not as rapidly expanded. In *K. paquettense* and *K. huronense* Foerste the ribs are slightly fewer, and both species are more slender.

Types.—Holotype and two paratypes, collection of the writer.

Occurrence.—With the preceding forms, Valcour limestone, near Little Monty Bay, southeast of Chazy Village, N.Y.

KIONOCERAS LAQUEATUM (Hall)
Plate 6, figures 11, 12

Orthoceras laqueatum HALL, 1847, Palaeontology of New York, vol. 1, p. 13, pl. 3, fig. 12 (not p. 206, pl. 56, fig. 2a–c).
Orthoceras (Kionoceras) laqueatum CLARKE & RUEDEMANN, 1903, New York State Museum Bull. 65, p. 627.
Orthoceras laqueatum RUEDEMANN, 1906, New York State Museum Bull. 90, p. 439.
Kionoceras laqueatum FOERSTE, 1921, Denison Univ. Bull., Sci. Lab., Jour., vol. 19, p. 273.
Orthoceras laqueatum FOERSTE, 1932, Denison Univ. Bull., Sci. Lab., Jour., vol. 27, p. 92.
Kionoceras? laqueatum ULRICH, FOERSTE, MILLER & UNKLESBAY, 1944, Geol. Soc. America Special Paper 58, p. 69.

Type and only known specimen, a shell 33 mm. long, subcircular in section, increasing from 4 mm. to 8 mm. in diameter. Only one side of the specimen is exposed, showing a surface marked by nine narrow rounded longitudinal lirae separated by broad flat interspaces. In four of the interspaces can be seen fainter longitudinal lirae, suggesting that the number of lirae increases adorally. Presumably between 16 and 20 of the lirae occupy the circumference of the shell at the stage known. They are slightly uneven in spacing around the circumference. Interspaces show only the faintest trace of numerous low transverse markings supplying a background for the lirae.

The spacing of the septa is not shown on the type. The apical end shows a section through the siphuncle, revealing that it is subcentral.

Discussion.—Reexamination of the type specimen upon which this species was based shows that the matrix is a light yellowish brown limestone, very pure, except for local surface silicification and the whole contains very little dolomite. The lithology is such as to suggest overwhelmingly Black River or lower Trenton beds, and is completely foreign to any horizon in the Canadian ("Beekmantown") in the Champlain Valley, Vermont, or the Phillipsburg section of Quebec. Ruedemann (1906) notes that the specimen came from drift, but states that it undoubtedly came from the Beekmantown formation "as we could convince ourselves on inspection of the same (the type) which is deposited in the State Museum (3909 of the type catalogue) from the character of the dolomite matrix." The writer finds it necessary to reject this view as the result of an extensive examination of the Canadian beds of eastern New York and Vermont. Further, the matrix bears fossil fragments, which though fragmentary and too incomplete for identification, include an ostracode, several brachiopod fragments of strophomenoid and dalmanelloid aspect, as well as some trilobite fragments. The whole assemblage is utterly unlike anything known in the Beekmantown, but suggests overwhelmingly faunas of Black River and lower Trenton age. In addition, no kionoceroid has yet been found beneath the Chazyan, and the present form agrees with the matrix and fragmentary fossil assemblage accompanying it, in suggesting Black River or lower Trenton assemblages.

In form, rate of expansion and spacing of the lirae, *K. laqueatum* is most similar to *K. paquettense* Foerste (1932, p. 92, pl. 37, fig. 2A–B) but as pointed out earlier by Foerste, *K. laqueatum* has considerably fewer longitudinal lirae around the circumference of the shell, having 16 to 20 where *K. paquettense* has about 35. The two species are known from approximately commensurate portions of the shell, making the difference conclusive.

Ruedemann (1906) believed that the early stages of *Protocycloceras* bore longitudinal markings like those of this group of kionoceroids, and figured as *Protocycloceras lamarcki* a small shell with kionoceroid markings from Spellman ledge at Beekmantown, New York. The specimen is an external mold of a tubular structure with faint longitudinal markings, but it is not even certain that it is a cephalopod. Further, these beds, now known to be middle Canadian and older than the upper Canadian Fort Cassin limestone, while they do contain an annulated shell of the aspect of *Protocycloceras* (Ruedemann, 1906, pl. 15, fig. 1), have as yet yielded no forms conspecific with those of the Fort Cassin beds. This form may or may not be a true *Protocycloceras*, but its specific affinities are certainly highly dubious, and will probably remain so, for all material is very fragmentary and preservation is extremely poor.

Type.—Holotype, New York State Museum, no. 3909.

Occurrence.—Drift; exact locality not known, formerly regarded as Beekmantown, but, as discussed above, more probably lower Mohawkian.

KIONOCERAS (?) WINDSORENSE Flower, new name

Orthoceras laqueatum DAWSON, 1868, Acadian Geology, 2nd ed., p. 311.
Kionoceras laqueatum BELL, 1929, Canada Geol. Survey Mem. 115, p. 182, pl. 33, fig. 2.
Not *Orthoceras laqueatum* HALL, 1847.

Dawson described as *Orthoceras laqueatum* a small kionoceroid shell from the lower Windsor series of Nova Scotia, which Bell redescribed as a species of *Kionoceras*. Since the species which Hall described under the same specific name has clear priority, and has, curiously, been assigned to both of these genera at various times, Dawson's name is clearly a junior homonym, and a new name is needed. Therefore I propose to rename the species *Kionoceras* (?) *windsorense*. The dubious generic reference is influenced largely by the fact that no true *Kionoceras* is known in rocks as young as the Mississippian; indeed the youngest kionoceroids known to me occur low in the Upper Devonian, and represent the last survivors of stocks better known and much better developed in the Middle Devonian. It is quite possible that better material may eventually show this species to belong to the genus *Thoracoceras*, better known in the Mississippian of Europe, and distinguished from *Kionoceras* by the presence of minute spines along the longitudinal ridges. The present illustrations and descriptions give no indication of such spines in this species, and consequently a reference of the species to *Thoracoceras* would not be justified by the present known morphological data.

KIONOCERAS DECORAHENSE Flower, n. sp.
Plate 6, figure 10

Shell moderately expanding as in *K. paquettense* and *K. laqueatum*, in contrast to the nearly tubular shells of many of the other Ordovician species of *Kionoceras*. The type, faintly flattened obliquely by pressure, increases from 6 mm. and 5.2 mm. to 12.5 and 10.6 mm. in a length of 40 mm., and has a maximum length of 45 mm. Shell very slightly curved, with the venter, as judged from the cameral deposits, very faintly concave. This may or may not be the result of the slight distortion to which the shell has been subjected.

The surface, which is only the surface of an internal mold, shows 26 lirae around its circumference. They are low, narrow, rather faint, but sharply set off from the flat interspaces. They are faint and distant dorsally, clearer ventrally, and most closely spaced on the lateral zones. Here some of the lirae may be secondary.

Sutures straight and transverse, 20 camerae occupy the length of the type, and are spaced about five in a length equal to the mean adoral diameter of the shell. At the apex of the specimen the siphuncle is small, slightly nearer the venter than the dorsum. Its structure has not been observed, but in obviously related species it is known to be perfectly tubular. The apical part of the type shows clearly the internal mold of cameral deposits, showing the extension of the interior on the left of the center, as oriented in our figure. This is probably the homologue of the midventral boss of *Michelinoceras ludlowense* and the ventral sinus of the deposits of the Pseudorthoceratidae, a pattern which is also shared by many Michelinoceratidae.

Discussion.—The appearance and spacing

of the lirae, closer ventrally than dorsally, and closest on the lateral regions, is a highly distinctive feature which will serve at once to distinguish this species. In rate of expansion it is allied to only a relatively small group of species, none of which are known to show this feature. Fine surface markings are unknown, because the type and only known specimen is an internal mold.

Holotype.—New York State Museum.

Occurrence.—From the Decorah shale of Decorah, Iowa.

Genus WHITFIELDOCERAS Foerste 1933

A complete discussion of the genus and a listing of the species then known has been previously presented (Flower, 1946, p. 177). In form, the genus is very distinctive in its fusiform living chamber, straight shell, and the central nummuloidal siphuncle. In New York, Ontario and Quebec the genus is not common, but appears to be confined to the Sherman Fall limestone and its equivalents. Two new species are described below, both of which come from this interval. In addition, a natural weathered section, inadequate for close specific evaluation, was collected by the writer from the basal beds of the Sherman Fall equivalent, directly overlying beds correlated with the Hull, from the Montmorency River, near Quebec City. The somewhat higher horizon in the bed of the Laval River, has yielded no *Whitfieldoceras* as yet.

WHITFIELDOCERAS GRACILE Flower, n. sp.
Plate 6, figures 16, 17

This *Whitfieldoceras* is distinctive in its very small size. The type is 22 mm. long, slightly depressed in section, venter and dorsum equally rounded throughout. Ventral profile convex over gibbous portion at base of living chamber, becoming essentially straight both adorally and adapically. Dorsal profile faintly concave adapically, faintly convex over base of living chamber, the curvature decreasing adorally to aperture. Lateral outline fusiform, sides becoming convex over gibbous region, the curvature decreasing to the aperture. Shell expands from 3.5 mm. and 4 mm. at base to 6 mm. and 7 mm. at base of living chamber, in a length of 15 mm. The phragmocone contains six normal camerae, part of a seventh at the base, and one very short camera at the base of the living chamber. Typical camerae are deep, averaging 2.5 mm. Shell essentially straight apically, with a suggestion of exogastric curvature over gibbous portion. Living chamber 6 mm. long, contracting to 5 mm. and 6 mm. at aperture.

Discussion.—Two closely comparable forms are *W. exiguum* (Whitfield) from the Trenton of L'Original, 52 mi. east of Ottawa, and *W. trentonense* Foerste of the Trenton of New York. *W. trentonense* is based upon two specimens so different that, without evidence of a connection, I am inclined to regard as two different species. The holotype (Foerste, 1931, 1932, pl. 32, fig. 7A, B) is a very gradually enlarging shell, larger than our present species, and much more tubular, less gibbous. The paratype, however, is a much smaller shell, comparable in proportions to the present species, but considerably more slender and less gibbous. Foerste (1932, pl. 32, fig. 9A–C) was unable to find Billings' type, but the material which he figures is a form representing a slightly larger species than ours, with a longer and less rapidly contracting living chamber. The spacing of the camerae in *W. gracile* is practically identical with that of *W. exiguum*.

It is even possible that *W. exiguum*, *W. gracile* and *W. trentonense* may eventually prove to be various expressions of a single highly plastic species. The morphological differences are such as separate other species in the genus, and it seems wisest to retain these standards until definite evidence indicates that they should be rejected.

Type.—Holotype, collection of Dr. G. W. Sinclair

Occurrence.—Sherman Fall limestone, Lakefield, near Peterboro, Ontario.

WHITFIELDOCERAS LENTICONTRACTUM Flower, n. sp.
Plate 7, figures 5, 6

Shell so essentially straight that orientation is determined only by gibbosity of the mature portion. Cross section faintly compressed, not depressed as in most species; venter slightly more convex in profile than dorsum. Dorsum and venter both straight apically, diverging gently to base of living chamber, where both become faintly convex,

the convexity of the venter the greater of the two; then subparallel to aperture where the faintest trace of concavity appears. Sides straight to base of living chamber, where they assume a nearly parallel condition, again with a vestigial concavity near aperture. Type 39 mm. long, increasing from 6 mm. and 6 mm. at base to 9 mm. and 9.5 mm. in basal 18 mm., while in the succeeding 18 mm. the height and width remain essentially unchanged. The basal 16 mm. pertain to the phragmocone. Three adoral camerae can be faintly seen through the test, which is preserved over the entire specimen. These measure 2.5 mm., 2.5 mm. and 2 mm. in length, the last being contracted.

Discussion.—The faintly compressed condition of the shell sets this species apart at once from its congeners. In general proportions of the exterior it is perhaps closest to *W. exiguum*, as redescribed by Foerste, but the spacing of the camerae is somewhat different, the fusiform contraction of the living chamber is much less marked, and the whole shell is straighter. Most similar of the previously described species is *W. clarkei* Foerste, but there the ventral profile is more strongly geniculate over the gibbous portion of the shell, and the living chamber is gently but definitely contracted beyond this point to the aperture, instead of remaining subtubular beyond a vestigial contracted zone.

Holotype.—New York State Museum.

Occurrence.—From the lower 50′ of Trenton, Little Chazy River, New York. This data, from an old label, may safely be interpreted as lower 50′ of Sherman Fall limestone, for this locality.

Order ASCOCERATIDA
Genus PROBILLINGSITES Foerste
PROBILLINGSITES COBOURGENSIS
Flower, n. sp.
Plate 9, figures 5–7, 12–13

As usual in the genus, this species is known from a living chamber and a maximum of four camerae, earlier portions being molted in life. The most complete and least distorted specimen, the holotype (pl. 9, fig. 5) is 24 mm. across the plane of the suture vertically, and also 24 mm. high across the most gibbous portion. Dorsal length, 15 mm; ventral length 31 mm; ventral profile strongly convex over basal 25 mm., with radius of curvature of 22 mm., but becomes straighter at aperture. Distance from septum to aperture on venter is 31 mm., but 37 mm. if measured on the curving surface of the ventral face. Aperture 17 mm. high, estimated width, being incomplete, 20 mm. One side of the type is missing. A paratype, retaining four camerae, but lacking the adoral part of the living chamber, (pl. 9, figs. 6–7) has a phragmocone with a dorsal length of 9 mm., a ventral length of 13 mm. Sutures oblique, sloping orad on dorsum, where broad saddles are developed. Slight ventral saddles also appear. The slope of the sutures is uniform with the curvature of the conch, and the adoral camerae are not deeper on the dorsum than are the earlier ones.

The siphuncle, generally only faintly

EXPLANATION OF PLATE 7

All except fig. *10* approximately ×1.

FIG. *1*—*Diestoceras sinclairi* Flower, n. sp. Lateral view, venter on left. Terrebonne, Quebec. Sinclair coll., holotype. (p. 54)

2, 3—*Danoceras inutile* Flower, n. sp. Gull River formation, Lake St. George quarry, Orillia, Ontario. Holotype, (*2*) lateral (*3*) dorsal views. Sinclair coll. (p. 54)

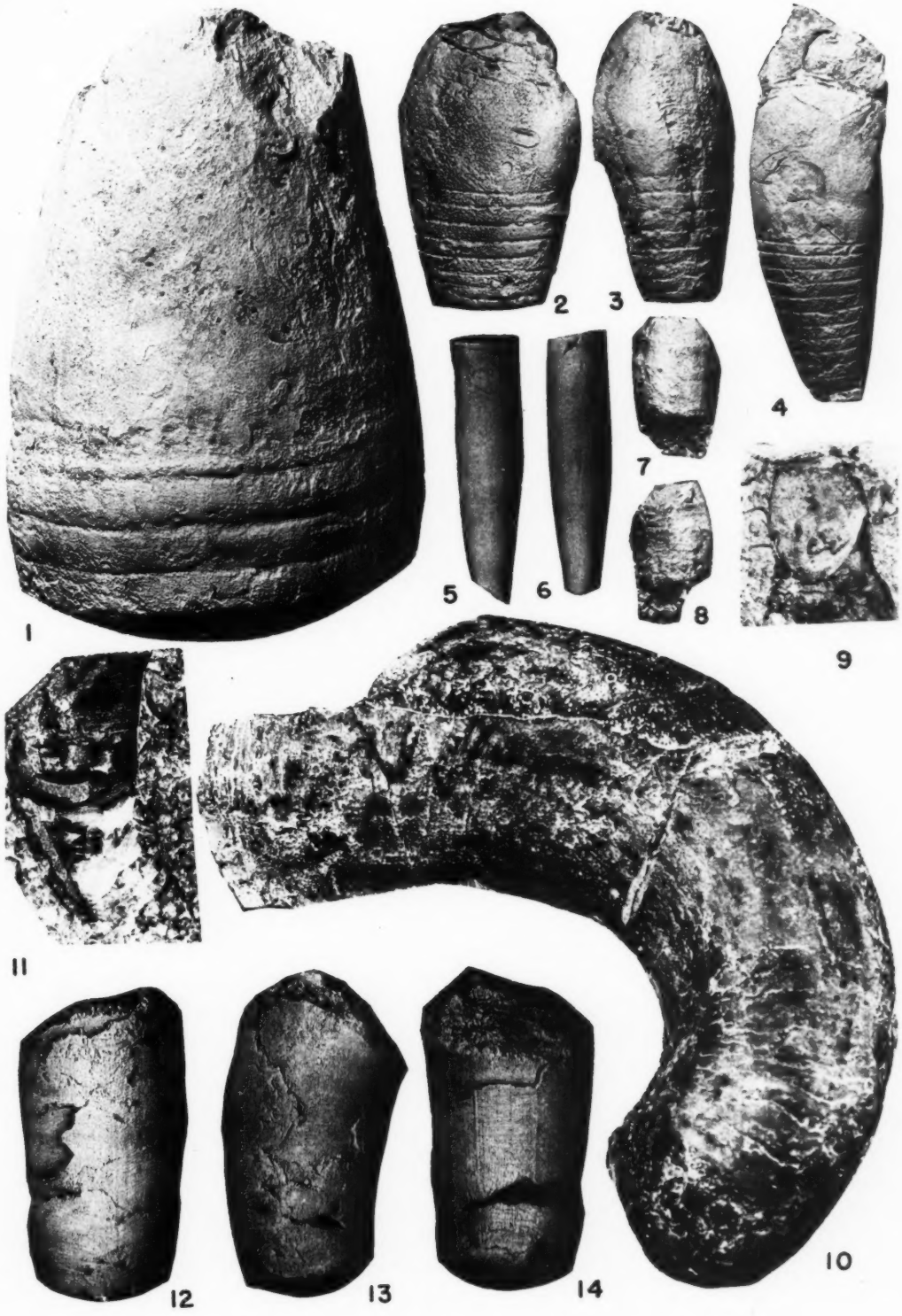
4—*Beloitoceras orilliense* Flower, n. sp. Gull River formation, Lake St. George quarry, Orillia, Ontario. Holotype, lateral view, venter on left. Sinclair coll. (p. 47)

5, 6—*Whitfieldoceras lenticontractum* Flower, n. sp. Lower 50′ of Trenton limestone, Little Chazy River, New York. Holotype, (*5*) ventral (*6*) lateral views. (p. 43)

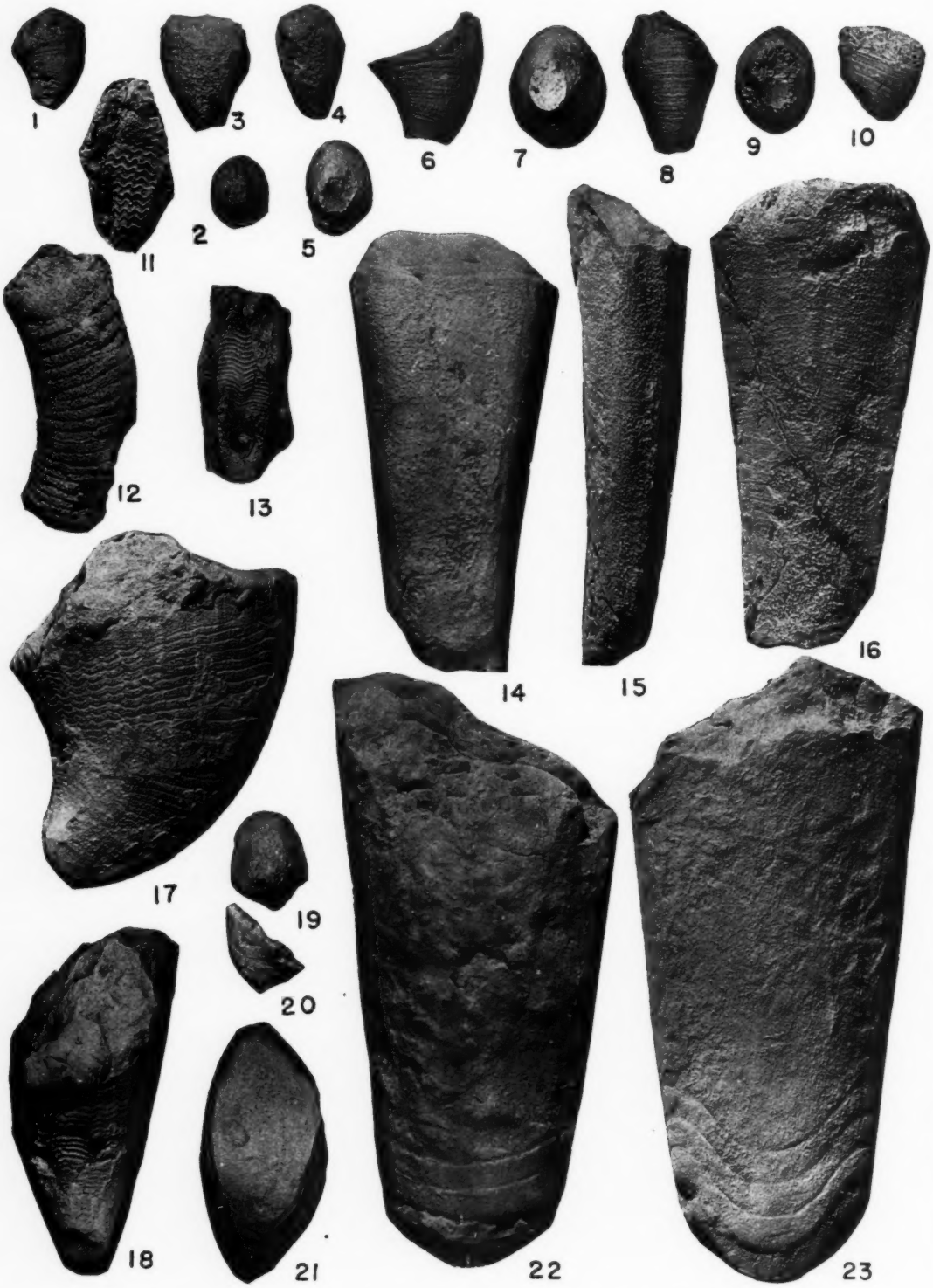
7–9—*Zitteloceras praecedens* Flower, n. sp. Middle Chazy limestone, fields on western edge of Chazy, New York. Holotype, (*7*) ventral, (*8*) lateral view, venter on right, (*9*) natural section. (p. 50)

10—*Fremontoceras giganteum* Flower, n. sp. Tetreauville formation, Montreal, Isle Jesus. Sinclair coll. About one-third natural size. Holotype, lateral view. (p. 57)

11–14—*Cyrtorizoceras rusti* Flower, n. sp. Holotype. Trenton limestone, Trenton Falls, N. Y. (*11*) section ×2; (*12*) ventral (*13*) lateral and (*14*) dorsal views, ×2, showing fine surface ornament. (p. 49)



Flower, Ordovician eastern North American cephalopods



Flower, Ordovician eastern North American cephalopods

indicated at the septal foramen, lies about half way between the center and the ventral wall. The septum of truncation is broadly rounded, so that its suture is obscure; adoral septa become increasingly flat.

Discussion.—The suite of specimens upon which this species is based show apparent variation in size and shape which upon closer examination are revealed as the result of slight distortion, the loss of the adoral part of the living chamber in some individuals, and the loss of the camerae of the mature phragmocone.

This species belongs with *P. welleri*, *P. williamsportensis* and *P. milleri* in that the adoral camerae do not show a progressive prolongation in depth on the dorsum, but all mature sutures are nearly uniform in their obliquity. The only species described previously from the Cobourg limestone, *P. primus* Fritz (in Parks, 1928, p. 85, pl. 1, fig. 8–10) is very different, apparently a more strongly depressed shell, with the sutures sloping much more strongly orad on the dorsum, apparently also (pl. 1, fig. 10) with a fusion of the sutures on the lateral region of the shell. Our form is also somewhat larger. Distortion makes difficult an accurate restoration of the cross section of our species, but evidently the conch was rounded equally on dorsum and venter, and slightly broader than high. A septum, the penultimate one, of one specimen (pl. 9, fig. 12) is figured as an apparently undistorted one, though one side is partially missing.

Types.—Holotype and four paratypes, collection of Dr. G. W. Sinclair.

Occurrence.—Cobourg limestone, Cobourg, Ontario.

PROBILLINGSITES INFLATUS Flower, n. sp.
Plate 9, figure 2

This species is known from a strongly inflated living chamber and two attached camerae, is 50 mm. in length, 34 mm. in height at the middle, with a corresponding width estimated at 32 mm. The compressed nature of the section is quite plainly the result of distortion. Ventral profile strongly convex throughout, radius of curvature 30 mm., the ventral outline becoming only slightly straighter at the extreme adoral end. Dorsal profile very faintly concave. The two camerae are each 6 mm. deep ventrally, and 4 mm. and 5 mm. deep dorsally. Septa are strongly curved, as can be seen from the type in which they are shown in natural vertical section. No trace of the siphuncle is preserved. Living chamber with a ventral length of 30 mm., dorsal length of 10 mm., and a length on the curving ventral face of 45 mm. Apparently the apertural part of the shell is not produced, as is the case in some species of the genus, but adorally the shell is very poorly

EXPLANATION OF PLATE 8

FIGS. *1, 2—Cyrtocerina foerstei* Flower, n. sp. Paratype, U. S. National Museum, ×1 (*1*) lateral, (*2*) apical views. Kimmswick limestone, Glen Park, Missouri. (p. 29)

3–5—Cyrtocerina kimmswickense Flower, n. sp. Holotype, U. S. National Museum, ×1. (*3*) lateral (*4*) ventral (*5*) apical views. Kimmswick limestone, New Hope, Missouri. (p. 28)

6–8—Cyrtocerina foerstei Flower, n. sp. Holotype, U. S. National Museum, ×1. (*6*) lateral (*7*) apical and (*8*) dorsal views. (p. 29)

9, 10—Cyrtocerina kimmswickense Flower, n. sp. Paratype, U. S. National Museum, ×1. (*9*) apical and (*10*) lateral views. Kimmswick limestone, Glen Park, Missouri. (p. 28)

11, 12—Zitteloceras terranovicum Flower, n. sp. (*11*) paratype ×1, an incomplete specimen showing surface ornament; (*12*) holotype, an internal mold, lateral view. Long Point series, Newfoundland. Sinclair coll. (p. 51)

13—Zitteloceras sp. Lowville limestone, Margaret quarry, Ottawa. R. H. Flower collection. (p. 51)

14–16.—Triptoceras cariniferum Flower, n. sp. Holotype ×1. (*14*) dorsal (*15*) lateral, venter on left, (*15*) ventral views. Black River (Chaumont) limestone, Watertown, N. Y. U. S. National Museum. (p. 53)

17, 18—Cyrtocerina crenulata Flower, n. sp. Holotype, U. S. National Museum, no. 15696. (*17*) lateral and (*18*) ventral views. Beloit member, Platteville limestone, Beloit, Wisconsin. (p. 28)

19, 20—Cyrtocerina sp. ×1. (*19*) apical and (*20*) lateral views. Lowville limestone, Stewart Quarry, Ottawa. (p. 27)

21–23—Lambeoceras montrealense Flower, n. sp. Holotype, (*21*) apical (*22*) dorsal and (*23*) ventral views. Tetreauville formation, Upper Trenton, Isle St. Jean, Montreal, Quebec. (p. 32)

indicated. Obliquity of the three septa preserved seems to be very nearly equal.

Discussion.—The large size and strongly inflated condition of this species are distinctive features. The shell apparently attains its greatest width well orad of the base of the living chamber. In spite of the poor condition of the type and only known specimen, this is clearly a distinctive species, one readily recognized by its size and proportions.

Holotype.—New York State Museum.

Occurrence.—From the Cobourg limestone, South Sandy Creek, at Wardwell, three miles southwest of Adams, New York, and 18 miles southwest of Watertown, New York.

Genus CHOANOCERAS Lindström

CHOANOCERAS IMITANS Flower, n. sp.

Plate 6, figures 13–15

Type consisting of a nearly complete living chamber and five camerae, a cyrtocone, with radius of curvature of venter 13 mm., living chamber slender, depressed in section, dorsum and venter equally rounded. The living chamber increases from 32 and 26 mm. at the base to a width of 36 mm. in 50 mm., the height increases proportionately, but cannot be measured, owing to destruction of the dorsum. The ventral and maximum length of the living chamber is 72 mm. Phragmocone of five camerae, with basal septum subconical, the greatest depth lying in the ventral third, where it is 12 mm. deep, nearly half the height of the shell. Sutures slope apicad from dorsum to venter, but lack clear lobes and saddles, the only variation from a normal oblique suture being supplied by a slight flattening of the suture on the dorsal surface. The lower three camerae are subequal and occupy together a length of 10 mm.; the upper two occupy a length of 3 mm. The fourth suture is singular in that it lies close to the fifth except on the midventral region where it forms an individual lobe of its own, approaching close to the third suture. The siphuncle can be seen at its passage through the septum at the base of the type, where it is compressed, cuneate in cross section, higher than wide, the dorsal end narrowed. The internal mold is marked by faint growth lines and still fainter longitudinal markings.

Discussion.—Unfortunately the preservation of this unique form is such that it seemed unwise to sacrifice it in the hope that internal structure would be revealed by a section. It is not therefore known whether this species shows the internal angulation and fusion of the septa which characterize the only other known species of the genus. In form, cross section, sutures and basal septum, this species is very close to *Choanoceras mutabile*, the genotype and only formerly known species of *Choanoceras*. The clearest differences shown by the internal molds are (1) the basal septum of *C. mutabile* is deeper and more strongly conical in form, (2) the sutures are more evenly spaced in *C. mutabile*, the adoral camerae not being as markedly shortened.

Holotype.—Museum of Comparative Zoology, Harvard, no. 2145.

Occurrence.—Labeled only as coming from Illinois; happily the lithology is extremely distinctive, and indicates an origin in some part of the Platteville limestone of the Ordovician, being a brown to buff fine grained dolomite.

Order ONCOCERATIDA

Genus BELOITOCERAS Foerste

BELOITOCERAS LOBIFERUM Flower, n. sp.

Plate 9, figures 8, 9

This is a gibbous oncoceroid with the inflation of the shell well orad of the base of the mature phragmocone; ventral profile convex throughout, strongly curved only over lower part of living chamber; dorsal profile straight or perhaps very faintly concave over phragmocone, straight to middle of living chamber where it becomes first faintly convex, then faintly concave to aperture; lateral profile with sides straight and gently diverging, becoming slightly convex over lower part of living chamber, and converging gently to aperture. Shell increasing from 14 and 15 mm. at base of type to 20 and 22 mm. at base of living chamber. Phragmocone of seven preserved camerae, 20 mm. long ventrally, 13 mm. dorsally. Sutures with shallow lateral lobes, tending to slope forward on the venter increasingly as traced from apex to living chamber; venter with a rounded saddle, dorsum with a lower saddle interrupted by a series of median lobes, faint basally, prominent near base of living chamber.

Living chamber with a dorsal length of 24 mm., ventral length 26 mm., increasing from 20 and 22 mm. at base to 23 and 25 mm. near middle, contracting to 21 and 24 mm. at aperture.

Features of aperture obscure. Cross section at base of type a compressed ellipse, the venter not more narrowly rounded than the dorsum, a condition which is little modified throughout. Siphuncle obscure, lying close to venter.

Discussion.—This is one of those troublesome species assigned by definition of the genus to *Beloitoceras*, but gibbous enough to suggest instead *Oncoceras*. The species is distinctive in the development of small middorsal lobes. The broadly rounded rather than narrowly rounded venter is a further distinctive feature, setting it apart from all known species of both *Oncoceras* and *Beloitoceras*. It does not seem sufficient to justify the erection of a new genus, which would be perfectly possible from the viewpoint of generic definitions.

Type.—Holotype and only known specimen, collection of Dr. G. Winston Sinclair.

Occurrence.—From the conglomeratic limestones, middle Trenton, on the beach at Cap à l'Aigle, Quebec.

BELOITOCERAS ORILLIENSE Flower, n. sp.
Plate 7, figure 4

A more typical slender *Beloitoceras* in form, distinctive in the extremely slender phragmocone and relatively straight shell. Dorsum straight apically, very faintly convex adorally, with a shallow but conspicuous concave zone near aperture; venter straight, becoming very faintly convex near adoral end of living chamber, attaining a radius of curvature of 60 mm., becoming slightly straighter near aperture, without concave zone. Sides diverge, essentially straight, attaining slight convexity at base of living chamber, greatest width attained one-third of the way from base of living chamber to aperture, apparently gently converging and gently convex to aperture; exact form obscured by crushing.

Phragmocone 28 mm. on venter, 24 mm. on dorsum, increases from 9 to 19 mm. in height; estimated widths 7 and 16 mm. Cross section compressed, venter scarcely more narrowly rounded than dorsum. Sutures straight and transverse, not sloping, increasingly orad on venter as living chamber is approached. Siphuncle not observed. Eleven camerae are preserved, the last shortened, the others increasing only gently in depth from 1.8 mm. at the base to 2.5 mm. adorally.

Living chamber slender, venter faintly convex throughout in profile, dorsum at first faintly convex, then with a narrow concave zone, and slightly produced at extreme aperture. Aperture well preserved laterally and faintly convex orad. Hyponomic sinus broad and low. Living chamber 22 mm. long on venter, 20 mm. on dorsum, the shell height increasing from 19 mm. at base to 20 mm. near middle, decreasing to 19 mm. near aperture. Corresponding widths are lost by distortion; clearly a width of about 18 mm. is attained at the center where apparently dorsum and venter are nearly equally rounded in cross section. Surface features are not shown.

Discussion.—By its slender form and the position of the gibbous region on the living chamber, this is a *Beloitoceras*. The straightness, slender form, and transverse sutures are distinctive, as is the broadly rounded venter.

Forms most comparable in outline have shorter living chambers, the gibbous region is located on the phragmocone, and such shells are currently assigned to *Oncoceras*. This species occurring as it does in beds of possible Pamelia age, is not particularly diagnostic. It appears to be closer to undescribed Lowville oncoceroids, as yet known only from rather unprepossessing material, than to anything in the Chazyan.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—From the Gull River beds, (Okulitch) possibly of Pamelia age, Lake St. George quarry, north of Orillia, Ontario.

Genus SINCLAIROCERAS Flower, n. gen.

Genotype: *Sinclairoceras haha* Flower, n. sp.

Shell a compressed exogastric brevicone, apex strongly curved, rapidly expanding, attaining greatest width and height on the phragmocone of a mature individual. Shell assumes a strongly compressed cross section, the venter acute, the dorsum somewhat more broadly rounded. Sutures with faint lateral lobes, scarcely inclined orad from

dorsum to venter. Siphuncle ventral, the segments short and very broadly expanded within the camerae; organic deposits within siphuncle unknown. The shell contracts both vertically and laterally from a point well below the base of the living chamber to the aperture, the living chamber having the form of part of a strongly compressed slightly curved cone. Aperture transverse laterally, with a moderate ventral hyponomic sinus.

Discussion.—This genus is erected for a remarkable species which at first appears to be little more than a gigantic oncoceroid, conceivably referable to *Beloitoceras*. However, it may also be considered as a shorter edition of *Winnipegoceras*, a genus concerning the taxonomic position of which there remain some grounds for perplexity. It differs from both genera, however, in the extremely expanded segments of the siphuncle, in which it is more closely similar to some of the Westonoceratidae. Our material, however, fails to show clearly any organic deposits within the siphuncle, owing to recrystallization of all material, which would substantiate this relationship. Therefore, on the basis of form, this genus is tentatively included in the Oncoceratidae with which its form is at least consistent.

SINCLAIROCERAS HAHA Flower, n. sp.
Plate 9, figures 14–16; text-figure 1

The holotype consists of a living chamber and portions of two camerae which are illustrated, and a considerable adapical portion of a phragmocone which is not shown, but has been studied in section and which indicates that the adapical part is surprisingly strongly curved, the ventral profile being almost geniculate just below the base of the living chamber, at the region of greatest gibbosity. Farther apicad, the ventral profile is only slightly curved. Cross section near base of living chamber strongly compressed, venter subangular in cross section, dorsum more broadly rounded. Greatest width near midheight of cross section. Septa shallow, sutures with slight lateral lobes, apparently nearly normal to cross section near base of living chamber. Siphuncle close to venter, segments broadly expanded, from 2 mm. at septal foramen to a height of 7 mm., where the camera is only 3 mm. deep. Organic deposits in siphuncle, if any, were lost by recrystallization. Segments broadly rounded within camerae; septal necks evidently recumbent, and the expanded segments of the siphuncle are apparently broadly adnate to the septa at both ends. The two last camerae measure 4 mm. and 3 mm. in depth ventrally, the last being slightly shorter than the preceding. At the base of the living chamber the shell is 45 mm. high and 32 mm. wide. Ventral profile uniformly convex to aperture, radius of curvature very slight, about 200 mm., dorsum at first converging toward venter and faintly convex, then with a conspicuous constriction beyond which it flares slightly, very much as in *Beloitoceras orilliense*. Sides faintly convex basally and approaching gradually, losing their convexity near the aperture and from there approaching somewhat more gradually. The living chamber decreases to an aperture of 17 mm. and 36 mm., in a ventral length of 38 mm., a dorsal length of 28 mm. Aperture laterally somewhat oblique to plane of last septum, very faintly convex. Aperture transverse dorsally, but with a moderate hyponomic sinus on the venter. No trace of surface markings remains.

Holotype.—Collection of the author.

Occurrence.—Ordovician limestones, believed to be of Black River age, at the lower part of the section. Quarry at edge of Ste. Anne de Chicoutimi, Quebec.

Genus WINNIPEGOCERAS Foreste
WINNIPEGOCERAS SINCLAIRI Flower, n. sp.
Plate 10, figures 6, 8

The only *Winnipegoceras* yet found in the St. Lawrence Valley is a large rather rough internal mold 135 mm. long. Cross section at base 35 mm. high, 22 mm. wide, shell more narrowly rounded on venter than on dorsum, subacute, greatest width dorsad of center. Siphuncle 3 mm. wide, 4 mm. high at septal foramen, 3 mm. from venter. The phragmocone, 120 mm. on the venter and 76 mm. long on the dorsum, has a ventral radius of curvature of 110 mm., while the dorsum is very faintly convex over the middle portion, but faintly concave adapically. Sutures with lateral lobes, deeper adorally than apically, and becoming increasingly oblique, swinging forward on the venter. The 22 camerae are essentially subequal in length, increasing from 5 mm.

to 6 mm. on the venter, the last camera contracted to 4 mm. The phragmocone increases from 35 mm. and 22 mm. to 56 mm. and 45 mm. at the gibbous portion, contracting to 49 and 32 mm. at the level of the lateral lobe of the last septum. The living chamber, with a length of 45 mm. on the venter and 45 mm. on the dorsum, is evenly curved with the remainder of the shell, and contracts from 30 mm. and 45 mm. to 24 mm. and 37 mm. at the aperture, which is not clear and probably not quite complete.

Discussion.—This form in general aspect is not unlike *Winnipegoceras dowlingi* Foerste, from the Red River limestone of the Winnipeg region, though the camerae are much shallower, the living chamber shorter and apparently somewhat less prolonged adorally. *W. laticurvatum* (Whiteaves) is a more extreme form, with the living chamber tremendously prolonged adorally, becoming straight, while the phragmocone is much more strongly curved. Our form is relatively simple in relation to this species, which might or might not indicate an earlier age. I have made no attempt to study the siphuncle by sections in the type and only known specimen, having learned by bitter experience how rarely this limestone yields any trace of internal structure in these large cephalopods.

Holotype.—Collection of the writer.

Occurrence.—From the floor of the quarry at St. Bartholemew, Quebec, in the Terrebonne limestone.

Genus CYRTORIZOCERAS Hyatt

CYRTORIZOCERAS RUSTI Flower, n. sp.

Plate 7, figures 11–14

This is a small very gently expanding cyrtocone with fine transverse and longitudinal surface markings. The type, 32 mm. in length, consists of a portion of a calcite-filled phragmocone, embedded in matrix and sectioned vertically, and a free complete adoral portion. Cross section circular. The adoral portion increases from 9 mm. to 13 mm. in a ventral length of 20 mm. and a dorsal length of 19 mm., including a living chamber 12 mm. in length. Radius of curvature of venter 35 mm., shell gently and gradually expanding to aperture. Sutures straight and transverse. Eight camerae occupy a length equal to the adoral shell diameter. Septum evenly curved, depth one-fourth the shell height. Siphuncle slightly removed from venter, faintly scalariform in vertical section, the dorsal wall essentially straight, the ventral wall expanded. The ventral neck, however, is orthochoanitic, the ring expanded farther apicad in the segment, and meeting the next septum with a broad area of adnation. The angle of the neck on the dorsal side is considerably over 90°, but the ring meets the next septum with no area of adnation on this side. No trace of organic deposits can be found, though adapically the connecting ring is rather thick.

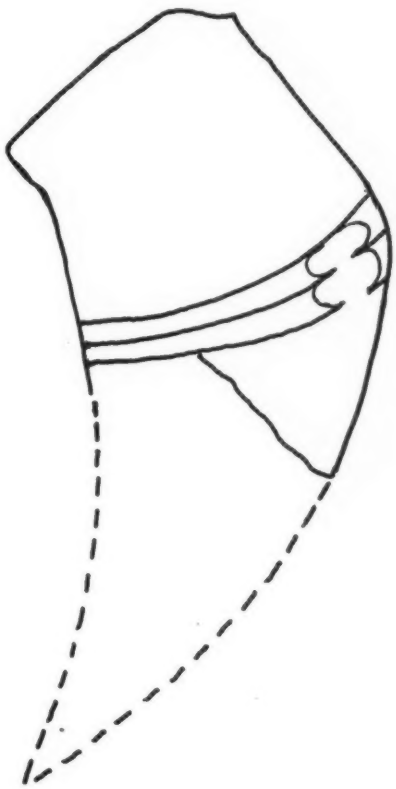


FIG. *1*—Restoration of *Sinclairoceras haha*, vertical section, indicating living chamber and attached camerae (see pl. 9, figs. *14–16*), extent of preserved portion of phragmocone, outline of siphuncle, and restoration of apical portion. 2/3 natural size.

Shell surface with fine transverse narrow striae with broader interspaces, about 20 striae in a length of 5 mm. These markings swing apicad on the venter, outlining the

hyponomic sinus. They are elsewhere transverse and without crenulations or other modification. Longitudinal ridges are present, coarser, somewhat more widely spaced, and uniformly more poorly defined, fainter, and are crossed by the transverse striae. A pair of dorso-lateral lirae is obviously stronger than any of the others.

Discussion.—In general proportions this shell resembles what is known of *Cyrtorizoceras constrictostriatum* (Hall) (see Foerste, 1928, p. 183, pl. 42, fig. 1A–C, 2A–B), but the striae are fainter, more closely spaced, and lack completely the lateral festooning shown in that species which, further, has no longitudinal elements in the surface. The aperture of that form is slightly contracted laterally, and the rate of expansion is slightly smaller than in our species. *Cyrtorizoceras filosum* (Conrad) is a much more rapidly expanding shell, more strongly curved, and attains a considerably greater size. This species is slender in relation to the genotype of *Cyrtorizoceras*, but agrees with it in the prominent transverse ornament, and is connected by intermediate species with the typical more rapidly expanding form.

Holotype.—New York State Museum.

Occurrence.—From the Trenton limestone, Trenton Falls, New York.

Genus ZITTELOCERAS Hyatt

For description and discussion see Flower 1946 (pp. 322–327). It now appears that the development and history of this group of frilled Ordovician forms is more ancient and more complex than was previously suspected. I had for some years regarded the fragment figured here from the Lowville limestone of Ottawa as the oldest representative of the genus; it was the oldest then known, and suggested an origin of the genus in *Cyrtorizoceras*, where transverse growth lines become fasciculate, and at length develop into the frills and annuli of *Zitteloceras*. This origin is still the most likely interpretation yet proposed. However, the middle Chazyan has yielded *Zitteloceras praecedens*, a form which shows none of the characters which, theoretically, ought to be primitive, but instead has well-crenulated frills, while the internal mold shows prominent longitudinal markings.

ZITTELOCERAS PRAECEDENS Flower, n. sp.
Plate 7, figures 7–9

The holotype is a small fragment with a maximum length of 18.5 mm., consisting of a poorly preserved phragmocone 9 mm. in length and a living chamber 9.5 mm. in length ventrally. Curvature is slight. The phragmocone increases from 6 mm. to 9 mm. in width, the living chamber expanding to 9.5 mm. The adoral 2 mm. of the living chamber shows a slight constriction, suggesting that the type represents a mature individual and nearly attains the aperture. Cross section subcircular, living chamber 9 mm. in both width and height at base, slightly narrower ventrally than dorsally, but with a slight flattening of the ventral face, on the sides of which the sides are straighter than in a corresponding region on the dorsum. Without the ventral zone, the venter would be definitely more narrowly rounded than the dorsum, as in most oncoceroids.

Septum at base of living chamber shallow, its suture straight and transverse. The adoral part of the phragmocone is filled with coarse calcite, obscuring septation and all other internal features. The siphuncle is small and ventral. At the base of the specimen three camerae occupy a length of 4 mm.

The surface of the living chamber shows faint transverse lines which mark the bases of frills. They are too faint here for the spacing to be measured accurately. The broken matrix shows, however, several cross sections of the frills, and the natural weathered section at the adoral end of the specimen shows them in oblique section. Frills are faintly crenulate, occurring 12 to 13 in a length of 10 mm., varying in length, long frills, their tips transverse to the axis of the shell, alternate with frills barely half their length. One to three short frills may intervene between two long ones; the arrangement of the longer and more prominent frills is evidently irregular.

Discussion.—This is evidently one of the rarer Chazyan species, for in spite of extensive collecting, I have found only the type specimen. Its distinctive features are the flattened venter in cross section, which is in itself enough to distinguish this form from all previously described species, its small size, irregularly alternating strong and weak

frills, and the presence of faint longitudinal markings on the internal mold of the living chamber. The ornament pattern is much more specialized than is anticipated in this, the oldest species of the genus so far known.

Holotype.—Collection of the author.

Occurrence.—Middle Chazyan, one-quarter mile southwest of Chazy Village, from B2 of Brainerd and Seely's section.

ZITTELOCERAS sp.
Plate 8, figure 13

The Lowville beds of Ottawa have yielded crushed fragments of a small cyrtocone, gently expanding, of uncertain cross section, which bear relatively narrow rounded transverse ridges on the surface of the shell. They are separated by relatively broad flat interspaces without finer markings, and swing apicad on the venter indicating the hyponomic sinus. No crenulations mark these frills, which are low, and they appear to have no expression on the interior of the shell as in the group of *Zitteloceras billingsi*. Shells with such ornament were set apart in the genus *Laphamoceras* by Foerste, but the genotype belongs to a group of species in which the transverse markings, though scarcely crenulate, are markedly fasciculate, unlike the present form, and clearly no sharp line can be drawn between *Laphamoceras* and *Zitteloceras*. In general aspect this species is close to *Zitteloceras billingsi*, but the shell appears to be more slender, is probably less curved, and the transverse markings are considerably less prominent, clearly making no impression on the internal mold, and are much more closely spaced.

Discussion.—This form, though always found more or less crushed and usually in small fragments, is apparently quite common in the shaly layers of the Lowville limestone near Ottawa. I have as yet failed to recognize it in the Lowville of New York. Cyrtocones in that formation are usually found in calcilutites from which it is impossible to extract specimens showing the surface. It is highly probable from the abundance of such cyrtocones that this *Zitteloceras* may be among them. The present species is included because, though I consider the fragment too poor to be the type of a species, the presence of shells of this sort in rocks of Lowville age has not been recorded.

Figured specimen.—Collection of the writer.

Occurrence.—Lowville limestone, Ottawa. From Foster's quarry, better known among paleontologists locally as Margaret's quarry.

ZITTELOCERAS TERRANOVICUM Flower, n. sp.
Plate 8, figures 11, 12

Shell gently curved, radius of profile of venter 40 to 50 mm. The shell increases from 11 mm. and 12 mm. to 14 mm. and 17 mm. in a ventral length of 40 mm., cross section compressed, dorsum and venter equally rounded, greatest width at center of shell height. Septa describe very shallow lateral lobes and are faintly inclined orad on the venter. Siphuncle small, close to venter, its segments plainly contracted slightly at the septal foramina.

The surface, shown by a fragment representing a moderately early portion of the shell, bears prominent distant crenulated frills, 1 mm. to 1.2 mm. apart. Crenulations rounded, even, two to three in a space 5 mm. wide. The shell lacks finer frills, those present being evenly spaced and regular, and there are no fine markings visible in the interspaces.

Discussion.—On the basis of ornament this species belongs in the group of *Zitteloceras hallianum*. It differs from that species in the larger size, the regularity of the frills, both sinuses and crests being equally rounded in the present form. *Z. clarkeanum* is a more rapidly expanding species in which the frills are more finely crenulate. In other species the frills are scarcely crenulate if at all, as in *Z. beloitense*, *Z. hitzi*, *Z. shideleri*, or alternate in strength as in the group of *Z. clarkeanum*. The compressed cross section may supply a difference more apparent than real, for in many species of *Zitteloceras* the shell is thin and specimens are evidently somewhat distorted, leaving some doubt as to the true nature of the cross section, which appears at least to be circular or slightly depressed in the majority of forms.

Types.—Holotype and paratype, collection of Dr. G. Winston Sinclair.

Occurrence.—From the Long Point series of Newfoundland, collected by J. C. Calder.

Genus LAVALOCERAS Flower, n. gen.

Genotype: *Lavaloceras geniculatum* Flower, n. sp.

Shell breviconic, faintly exogastric, cross section rounded, venter arched, dorsum somewhat flattened, section may be slightly broader than high but is generally slightly compressed. Sutures straight and transverse, without lateral lobes. Siphuncle ventral, evidently expanded within the camerae, its detailed structure not known. The shell expands to the adoral third of the mature phragmocone, is gibbous in that area, and begins to contract, tapering gently toward the aperture from a point at or below the base of the mature living chamber, giving the shell a fusiform outline. In this respect the genus recalls *Winnipegoceras*, but differs in that the shell is much less curved, lacking the strong geniculation in the early part, the section is much broader and the sutures fail to develop lateral lobes.

Discussion.—The affinities of this genus are admittedly problematical. The only form which appears to be definitely related is *Winnipegoceras*, and both genera may belong to the Oncoceratidae, where they are tentatively included at present, but they may eventually prove instead to belong to the Westonoceratidae of the Discosoroida. Although only the genotype is described at the present time, there is at least one other species which occurs in the same association. Both are from the Terrebonne formation of the Montreal region. As yet, the genus is not known from any other locality or horizon.

LAVALOCERAS GENICULATUM Flower, n. sp.
Plate 10, figures 3, 4

Holotype a living chamber and four attached camerae, 90 mm. in length, slightly distorted obliquely, the section probably originally compressed, venter narrowly rounded, dorsum slightly flattened. The four camerae, complete on the dorsum, where they occupy a length of 25 mm., are weathered on the venter in such a way as to exaggerate the naturally strongly geniculate ventral outline there. The shell tapers, contracting from the base of the living chamber to the aperture, from a height of 48 mm. and a width of 50 mm. to a height of 25 mm. and a width of 35 mm. Probably the original height at the aperture was considerably greater, as there is evidence here of increased flattening. Dorsal profile nearly straight, faintly convex over adoral part of phragmocone, becoming straighter along the living chamber, and faintly concave in a zone near the aperture. Ventral profile strongly convex over adoral part of phragmocone, geniculate at base of living chamber, then straight or nearly so, approaching the dorsum rapidly to the aperture. The sutures are straight and transverse, the siphuncle poorly exposed, close to the venter. Aperture poorly preserved, but with a suggestion of a shallow hyponomic sinus.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—From the Terrebonne formation, Crabtree Mills, Quebec.

EXPLANTION OF PLATE 9

FIGS. *1, 4—Kionoceras polyplicatum* Flower, n. sp. Paratypes, ×2½, (*1*) showing depth of camerae decreasing orad, (*4*) showing fine surface markings. Valcour limestone, Little Monty Bay, Chazy, New York. (p. 40)

2—Probillingsites inflatus Flower, n. sp. Holotype, lateral view. South Sandy Creek, Wardwell, near Adams, New York. (p. 45)

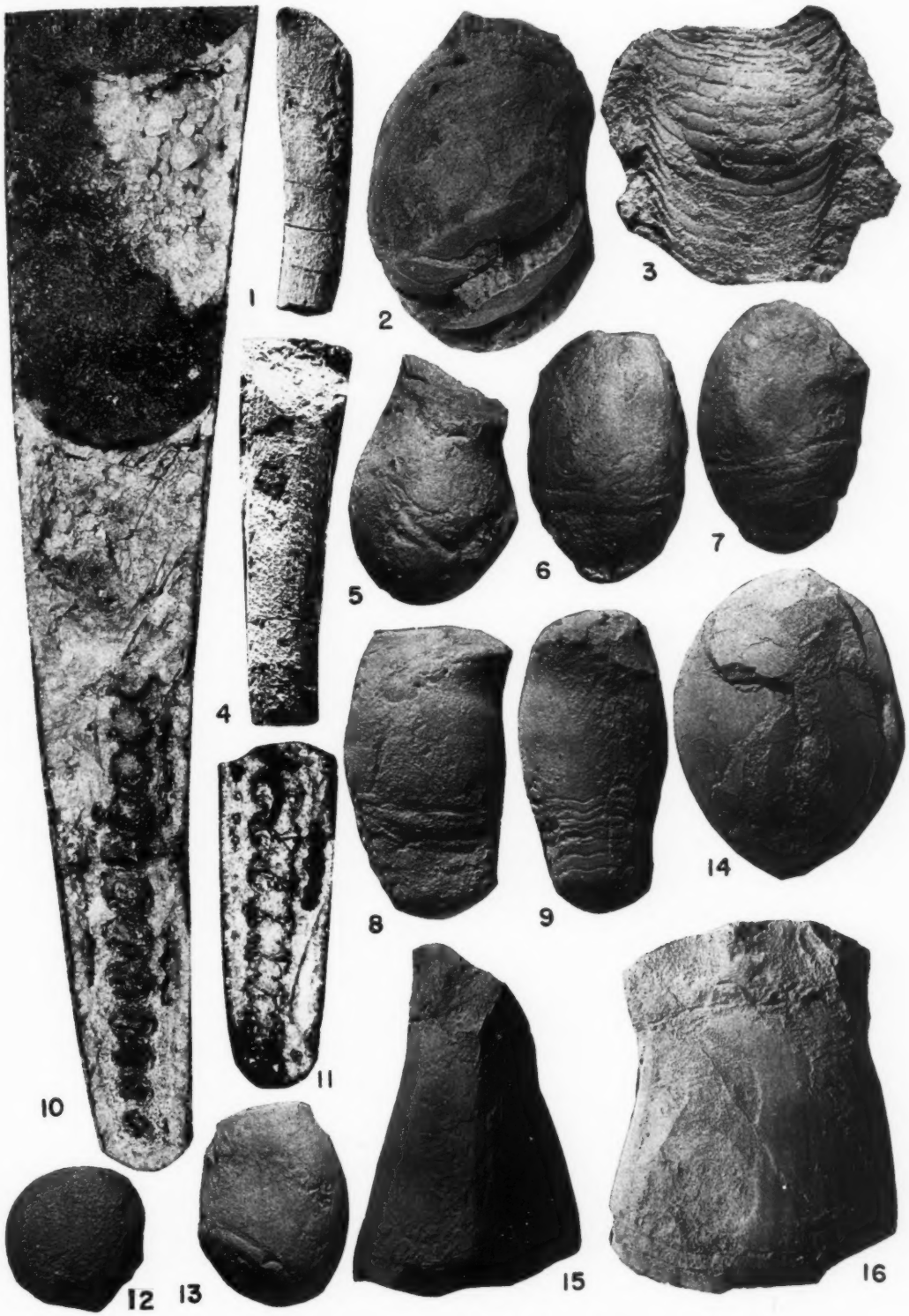
3—Gonioceras minor Flower, n. sp. Ventral. Long Point group, Newfoundland. (p. 31)

5–7, 12, 13—Probillingsites cobourgensis Flower, n. sp. (*5*) holotype, lateral view; (*6–7*) paratype, ventral and lateral views; (*12*) a nearly undistorted septum; (*13*) paratype, lateral view. Cobourg limestone, Cobourg, Ontario. (p. 44)

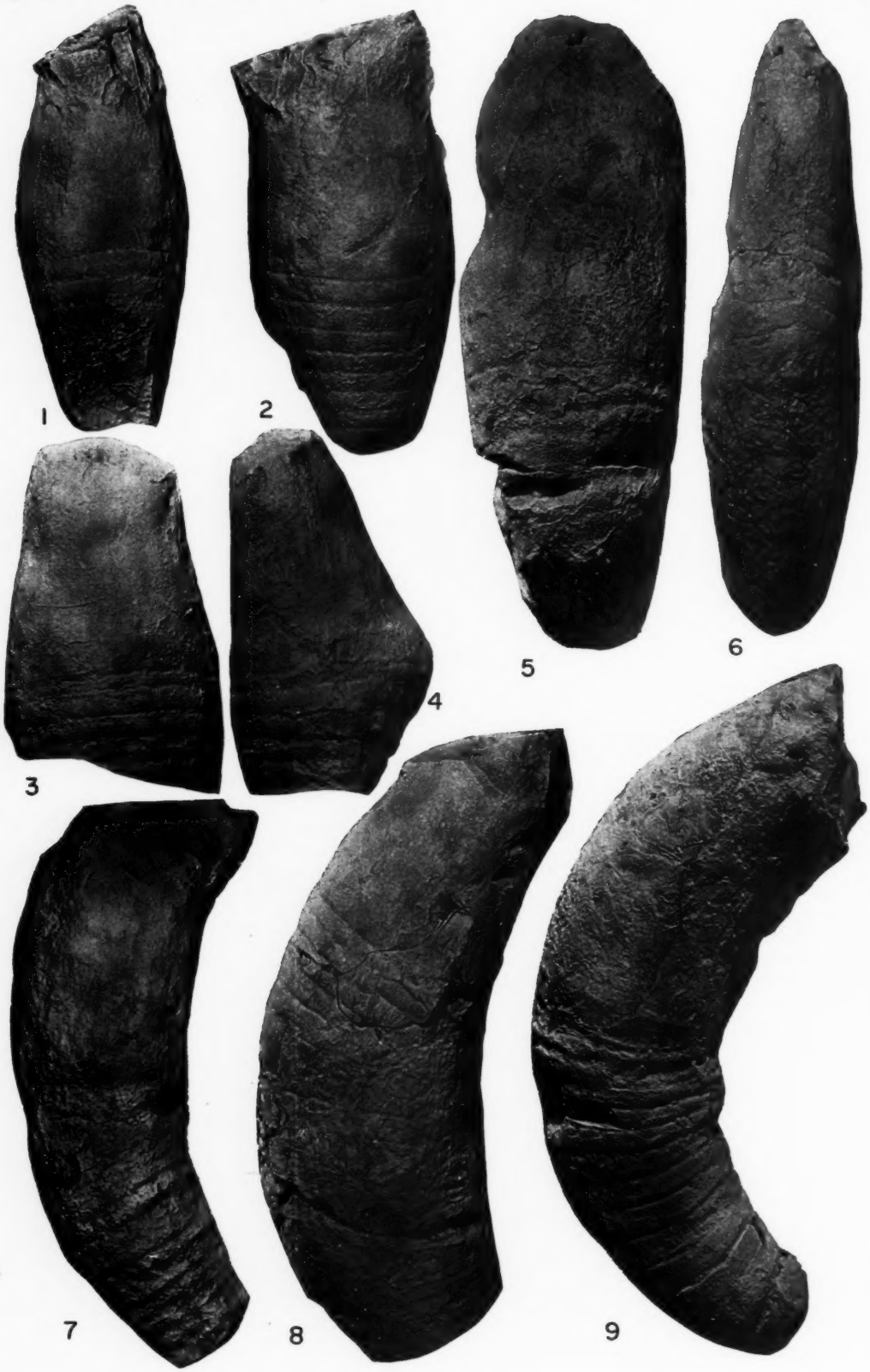
8, 9—Beloitoceras lobiferum Flower, n. sp. Holotype, (*8*) lateral (*9*) dorsal views. Middle Trenton, Cap à l'Aigle, Quebec. (p. 46)

10–11—Ormoceras champlainense Flower, n. sp. Holotype, (*10*) natural section of complete holotype. (*11*) section taken through center of siphuncle in apical portion. Lower Chazyan, Little Monty Bay, Chazy, New York. (p. 30)

14–16—Sinclairoceras haha Flower, n. sp., holotype, (*14*) septal view, venter beneath; (*15*) ventral view; (*16*) lateral view, venter on right. Ste. Anne de Chicoutimi, Quebec. (p. 48)



Flower, Ordovician eastern North American cephalopods



Flower, Ordovician eastern North American cephalopods

Genus TRIPTEROCERAS Hyatt

TRIPTEROCERAS CARINIFERUM Flower, n. sp.

Plate 8, figures 14–16

Shell strongly flattened, triangular, the dorsum faintly concave in vertical profile, the venter faintly convex, but more nearly straight. Cross section with venter flat, broad, with narrow oblique ventrolateral faces sloping outward to narrowly rounded lateral angles. Dorsum rounded adapically, but develops a low median ridge which increases in prominence orad, the ridge being flanked by lateral zones which are faintly concave near the median ridge, then faintly convex over the central portions, becoming faintly concave again as they approach the lateral angles. Shell surface obscure ventrally, exceptionally clear dorsally, with fine transverse markings forming a broad low dorsal crest. The type increases from 19 mm. and 10 mm. to 33 mm. and 17 mm. in the length of 55 mm. Maximum length of type 65 mm. The features of the phragmocone are not clearly displayed.

Discussion.—This *Tripteroceras* is distinctive in the oblique ventrolateral zones and the undulate character of the dorsum in cross section, as well as the faint exogastric curvature of the entire shell. A somewhat similar dorsal surface has been noted in *Rasmussenoceras variabile* Flower of the upper Richmond of Ohio and Indiana, but in that form the dorsum becomes smooth and more uniformly convex adorally. *T. planoconvexum* and *T. hastatum* differ in the proportions, lack the undulate dorsum, and the regions comparable to the ventrolateral zones lie dorsad of the strong lateral angles and converge dorsad instead of ventrad. The species is rare in the Black River limestone. Aside from the type, I have obtained only one other specimen.

Type.—Holotype, U. S. National Museum, no 59576.

Occurrence.—From the Chaumont limestone, Black River group, near Watertown, New York.

Genus VALCOUROCERAS Flower

VALCOUROCERAS ELONGATUM Flower, n. sp.

Plate 10, figure 7

The type is a relatively complete shell, one side of which is lost by weathering. The surface of the internal mold is somewhat rough, evidently having been modified slightly by pressure, but the septa have not been distorted and alteration is probably slight. The phragmocone of 16 camerae increases in height from an estimated 34 mm. to 42 mm.; ventral length 85 mm., radius of curvature 110 mm. basally, increasing on the living chamber to 150 mm. Camerae increasing only gradually in length, from 3 mm. to 5 mm. on venter, lateral lobes scarcely developed. Sutures tend to slope slightly orad from dorsum to venter on the adoral end of the phragmocone. Siphuncle ventral, its structure has not been observed, but it is typical of the genus in size. Living chamber 70 mm. in length, relatively slender for the genus, scarcely inflated, showing a slight contraction near the aperture, which is 46 mm. in height. Corresponding widths cannot be obtained owing to the loss of one side of the specimen by weathering. Evidently the cross section is compressed, the venter more narrowly rounded than the dorsum, greatest width well dorsad of the middle of the shell, dorsum somewhat flattened.

EXPLANATION OF PLATE 10

All figures two-thirds natural size.

FIGS. *1, 2—Diestoceras lavalense* Flower, n. sp. Holotype, (*1*) ventral ? and (*2*) lateral views. Terrebonne formation, Isle St. Jean, Montreal, Quebec. (p. 54)

3, 4—Lavaloceras geniculatum Flower, n. sp. Holotype, (*3*) dorsal view; (*4*) lateral view, venter on right, base of ventral surface altered by weathering. Terrebonne formation, upper Trenton, Crabtree Mills, Quebec. (p. 52)

5, 9—Apsidoceras quebecense Flower, n. sp., Holotype, (*5*) ventral and (*9*) lateral views, Terrebonne limestone, Crabtree Mills, Quebec. (p. 56)

6, 8—Winnipegoceras sinclairi Flower, n. sp. Holotype, (*6*) ventral (*8*) lateral views. St. Bartholomew, Quebec. (p. 48)

7—Valcouroceras elongatum Flower, n. sp. Middle Chazy limestone, Valcour Island, Lake Champlain. Holotype, lateral view. (p. 53)

Discussion.—This species is distinctive among the *Valcouroceras* so far known from the Chazyan in its slender form, and the reduced gibbosity of the living chamber. Other species are more strongly curved, more rapidly expanding, and the living chamber is more strongly inflated.

Holotype.—U. S. National Museum.

Occurrence.—Middle Chazy limestone, Valcour Island, Lake Champlain, N. Y.

Genus DANOCERAS Troedsson

DANOCERAS INUTILE Flower, n. sp.
Plate 7, figures 2, 3

Shell straight, expanding gently to middle of living chamber where contraction begins to the aperture. Shell strongly compressed, oval in cross section, venter more narrowly rounded than dorsum on phragmocone, both equally rounded on living chamber. Type consists of a nearly complete living chamber and eight camerae. Phragmocone 17 mm. long on venter, 16 mm. on dorsum. Sutures straight and transverse. Siphuncle not observed, septa shallow, camerae subequal in depth in extant part of phragmocone, increasing from 2 mm. to 3.5 mm. in depth, the last camera somewhat shortened gerontically. Living chamber 24 mm. long, increasing in height from 25 mm. to 27 mm. just beyond midlength, then contracting rather strongly to the aperture which is 20 mm. high, ovate, more broadly open on the dorsum than on the venter, with a maximum width of 12 mm. There is no well defined hyponomic sinus. Surface features not preserved.

Discussion.—Orientation is based upon the absence of the siphuncle on the more broadly rounded side of the cross section where the septal surface is well preserved and void of any such structure. The part of the septum on the opposite side where the siphuncle may be expected is inadequately preserved. In form this species fits readily within the limits of the genus *Danoceras*, being perhaps closer to *D. scandanavicum* Strand of the Kalholn limestone of Oslo, than to any other species. It differs from that one in that the aperture is dome-like, not markedly produced, and the sutures are perfectly straight laterally. Indeed, the absence of lateral lobes distinguishes this species from all others which have previously been placed in *Danoceras*.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—Gull River formation (*Beatricea* beds), Lake St. George quarry, north of Orillia, Ontario.

Genus DIESTOCERAS Foerste

DIESTOCERAS LAVALENSE Flower, n. sp.
Plate 10, figures 1, 2

Shell nearly straight, breviconic, compressed in section. The type expands from a width of 25 mm. and an estimated height of 35 mm. at the base, which is incomplete on one side, to 40 mm. and 49 mm. The phragmocone is 47 mm. long, containing nine camerae, increasing only gradually in length as traced orad, from 4 mm. to 7 mm. Sutures with only very faint lateral lobes. Internal structure not preserved. Living chamber 45 mm. in length, attaining an aperture of 45 mm. and 30 mm. The greatest height of the shell, 49 mm., is attained at the base of the phragmocone; the greatest width lies just above the base of the living chamber.

Discussion.—This is rather distinctive among other species of *Diestoceras* in the gentle vertical enlargement of the shell, the relatively uniform depth of the camerae, and the attainment of the greatest shell width above the region of greatest shell height. On the basis of related species, the venter is assumed to be the side which is less convex in profile, but there is no trace of either a siphuncle or a hyponomic sinus.

Type.—Holotype, collection of Dr. G. Winston Sinclair.

Occurrence.—From the Terrebonne formation, Isle St. Jean, Montreal, Quebec.

DIESTOCERAS SINCLAIRI Flower, n. sp.
Plate 7, figure 1

This is easily the largest of the several *Diestoceras* species of the Terrebonne formation of Quebec. Shell essentially straight, compressed in section, venter more narrowly rounded than dorsum. The type consists of a basal portion of poorly preserved camerae, not shown, 34 mm. in length, in addition to the portion shown. In the basal portion the camerae are present only on one side, and are filled with coarse calcite attached to the external mold of the remainder of the specimen. At the base of the illustrated portion, the shell is 60 mm. high, 45 mm. wide. In the length of the remaining part

of the phragmocone 25 mm. laterally, the shell becomes 57 mm. high and 47 mm. wide. In this length are four camerae terminated by a basal zone. The living chamber has a dorsal length of 50 mm., and a maximum lateral length of 60 mm.; the venter is incomplete adorally. Sutures have lateral lobes separated by a dorsal saddle and a narrower somewhat more prominent ventral saddle. The profile is convex on the venter, curvature being reduced at the adoral quarter of the living chamber, but the venter contracts throughout more strongly and is more oblique to the plane of the sutures than the dorsum. The greatest height of the shell occurs at the base of the living chamber; as in the preceding species, the greatest width of the shell lies on the basal fourth of the living chamber. Aperture and surface markings are not shown.

Discussion.—This is the largest *Diestoceras* yet found in the Terrebonne formation. Both this and the preceding species are distinctive among Trentonian species of the genus, being more of the aspect of those found in the boreal regions and in the true Richmond. It is the more significant that the presence of such types in late Trenton strata be recorded. In *D. sinclairi* the shell is nearly straight, but appears slightly exogastric from the greater curvature of the venter than the dorsum. This is the first species of the aspect of *Diestoceras* in which this condition is clearly demonstrable, though I have elsewhere suspected it; *Diestoceras* when first described was supposed to belong with endogastric cephalopods.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—Terrebonne formation, Terrebonne, Quebec, near Montreal.

DIESTOCERAS SYCON Flower, n. sp.
Plate 6, figure 8

A small top-shaped essentially straight brevicone, enlarging rapidly to base of mature living chamber, where all outlines become slightly convex owing to reduction in rate of expansion, and the sides approach each other very slightly at the extreme adoral end. Shell essentially circular in section. In the phragmocone of the holotype, with a maximum length of 31 mm., the shell increases from its tip, which is not quite complete, to a diameter of 26 mm. Only the last two camerae are visible, and are 2.8 mm. deep. Sutures straight and transverse, siphuncle not exposed. Living chamber with a ventrolateral length of 21 mm., shortened ventrally (to right of specimen as oriented on plate 6, fig. 8,) by the prominent rounded hyponomic sinus, which is incomplete, but easily 5 mm. deep and 16 mm. wide. Aperture incomplete, but the living chamber must increase from 26 mm. in diameter at the base to 29 mm., and then contract to 27 mm. at the aperture.

Only one side, that illustrated, of the type is shown; the shell is very nearly circular in section, the living chamber perhaps showing a slight tendency toward compression. Shell surface lacking, but the internal mold shows transverse growth lines indicating the rounded hyponomic sinus, but otherwise transverse.

Discussion.—This belongs to a group of small top-shaped brevicones which have been placed in *Diestoceras*, but which are all rather inadequately known, particularly in regard to internal structure, and which are not very similar in aspect to the larger and more typical representatives of the genus. Adequate grounds for subdividing *Diestoceras* have not yet been found, but the genus, and also *Danoceras*, is fast becoming a large one, rather heterogenous, but a vexing number of the species are unknown internally and relationships cannot therefore be determined with accuracy. In form this species is closest to *D. edenense* Flower (1946, p. 413, pl. 5, figs. 5–6) of the Eden beds of Cincinnati, a relatively tiny species, than to any form previously described from Mohawkian beds. In most species of *Diestoceras* the gibbosity lies somewhat lower on the shell. However, our holotype may not be quite mature, as no basal zone is present, nor is there definite shortening of the last camera. Even allowing for the probability that this shell may not quite have attained maturity, there is no species known which is at all closely similar in proportions. This is evidently one of those very rare forms from the Black River and Trenton, as it is known only from the type.

Holotype.—Museum of Comparative Zoology, Harvard, no. 5025.

Occurrence.—From "Black River limestone, near Poland, New York." In this region a few feet of Lowville are overlaid by

a massive limestone, weathering lighter, of Black River aspect, which are covered by beds currently correlated with the Hull or Kirkfield, which are of more typical Trenton aspect. The massive beds evidently are the source of this specimen. Whether they are Black River or Trenton is still debatable. In some respects the fauna is clearly not that of the Chaumont, and the beds may well be younger. The writer cannot agree, however, that their correlation with the Rockland necessarily follows.

Order BARRANDEOCERATIDA

Genus AVILIONELLA Flower, n. gen.

Genotype: *Tarphyceras multicameratum* Ruedemann.

Shell coiled, whorl section oval, compressed, venter slightly narrower than dorsum. Sutures with lateral lobes, swinging orad on venter. Siphuncle slightly removed from venter, tubular, the connecting ring thin and homogeneous in structure. Shell coiled with a very small umbilical perforation, and very closely coiled from initial portion, with the development from the completion of the first whorl of a shallow impressed zone. The impressed zone continues through succeeding whorls for a varying distance in different species; in the genotype it is fairly persistent, but in some other species, not yet described, the shell may become gyroconic at the completion of one and a half volutions. In any case, the adoral part of the shell becomes more loosely coiled, shown first by reduction and loss of the impressed zone, and finally by the development of a free gyroconic portion of the shell. The shell surface is relatively smooth, without costae, showing faintly fasciculate growth lines which slope apicad from dorsum to venter, where there is a deep hyponomic sinus.

Discussion.—The above generic description is based not only upon the genotype, but upon associated species as yet undescribed which differ from it more in the point at which the coiling is reduced than in any other feature. The genotype was described by Ruedemann as a species of *Tarphyceras*, incidentally the only one in beds younger than the Canadian. Other species show a closer affinity in the mature part of the shell to *Pycnoceras* and even *Aphetoceras*. However, they are typical of none of these genera. In the early stages an impressed zone is developed in the first whorl. In *Aphetoceras* no such impressed zone is ever developed. In *Pycnoceras* the umbilical perforation is much larger, and the impressed zone is not developed at once, but only later in the shell. In *Tarphyceras* the umbilical perforation is also small, but again the impressed zone is progressive, being gradually developed in the early part of the shell, and the impressed zone is not reduced gradually throughout the outer whorls, but is lost abruptly where curvature decreases in the last half or quarter volution of the mature shell. Much more significant, though more laborious to demonstrate is the difference supplied by the thin homogeneous connecting rings of *Avilionella*, which contrast strongly to the thick complex rings of the Tarphyceratida.

I have not included at present any illustrations of the genus. The genotype is quite adequately illustrated by Ruedemann, and redescription is delayed and will be accompanied by that of two other species, mentioned above, which differ from the genotype mainly in that the whorls become free at earlier stages. All three are found commonly in the *Glaphurus pustulatus* fauna of the Chazyan. Thus far only one additional form has come to my notice, a very incomplete specimen from the shaly beds of the Lowville limestone at Ottawa. *Centrocyrtoceras* Foerste I regard as closely related to this form. It has the same type of cross section, and the same phragmocone structure, but differs in having annuli or costae strongly developed on the surface, and in coiling, for the whorls are free throughout. *Paquettoceras* is sometimes similar in that the shell surface lacks annuli, but the siphuncle is more nearly central in position. Both genera are known mainly from lower Mohawkian faunas, but *Centrocyrtoceras* at least overlaps *Avilionella* in range, for one tiny species is known from the Valcour limestone, *C. mozolai* Flower.

Genus APSIDOCERAS Hyatt

APSIDOCERAS QUEBECENSE Flower, n. sp.

Plate 10, figures 5, 9

Shell probably cyrtoconic when complete, of less than half a whorl; early portion evidently rapidly expanding, section subcir-

cular, developing a slight flattening of the venter, which becomes more pronounced in the ephebic portion. Sutures straight and transverse in the young stage tending to develop slight lateral lobes, a slight ventral lobe, and adorally, a vestigial dorsal saddle, rounded and poorly defined. Siphuncle located about half way between the venter and the center; its structure not observed, cyrtochoanitic by analogy. Living chamber slightly inflated, tapering in adoral fifth to aperture, where both height and width decrease, and the curvature of the shell is somewhat reduced.

The holotype, the most complete specimen, increases in the length of the phragmocone, 112 mm. on the venter, from 27 mm. and 27 mm. to a height of 48 mm. and a width of 52 mm. Sutures develop faint lateral lobes early, but they are not accentuated markedly adorally as in *A. montrealense;* the ventral sutures are transverse, with only a vestige of a lobe; in lateral aspect the sutures are transverse, scarcely rising orad more on the venter than on the dorsum. Camerae are relatively deep in the early portion, four occur in a length equal to the adoral shell height of 40 mm. as taken on the venter; adorally at 50 mm., six camerae occur in a similar length. The last two camerae are markedly shortened, indicating maturity.

Radius of curvature nearly uniform, and 90 mm. throughout the extant portion, indicating, with the rapid initial rate of expansion, a shell which when complete was cyrtoconic rather than gyroconic; curvature reduced in extreme adoral portion, so that the radius there increases to 100 mm. Living chamber 135 mm. long on venter, increasing to 48 mm. and 60 mm. near the center, contracting gently to a height of 42 mm. and an estimated width of 52 mm. at the aperture, a small part of which is visible on the venter. Condition of aperture not clearly shown.

Two other reasonably complete specimens are at hand, which indicate only slight variations in proportion. A specimen from Isle St. Jean, Montreal, increases from 45 and 52 mm. at the base of the living chamber, to 47 and 50 mm., and contracts toward an incomplete aperture estimated at 40 and 50 mm.

A third specimen from Crabtree Mills, though incomplete, increases from 45 and 52 mm. to 46 and 58 mm., and contracts adorally; this specimen is slightly distorted obliquely. Both specimens exhibit curvature and proportions of phragmocones similar to those of the type. None of the specimens preserve surface features.

Discussion.—This form is strikingly different from *A. montrealense* of the Tetreauville beds; the section is broader in proportion to the height, the dorsal saddles are less well marked, and in that form the depth of the lateral lobes increases very rapidly and becomes much deeper. That form has a much narrower and less clearly defined venter, and the living chamber is markedly less gibbous.

Though this form retains certain features of *A. montrealense* which may be looked upon as primitive, it is more advanced than that form. The primitive features, however, are those which distinguish it from forms from other areas which are, at least supposedly, younger. The venter is not as markedly flattened, the ventral lobe is vestigial, the dorsal saddle is round, low, and indistinct. The form is, further, definitely cyrtoconic, rapidly expanding in the young, and the living chamber is very faintly gibbous. Both features suggest the genus *Deckeroceras*, which is a shorter shell, much more gibbous, but with a more generalized suture pattern, and a siphuncle closer to the venter.

This species is not uncommon in the Terrebonne. Beside the three types, two specimens from Crabtree Mills, and one from Isle St. Jean.

Types.—Holotype and two paratypes, G. W. Sinclair collection.

Occurrence.—Terrebonne beds, uppermost Trenton, Montreal and vicinity.

Genus FREMONTOCERAS Foerste

FREMONTOCERAS GIGANTEUM
Flower, n. sp.
Plate 7, figure 10

The type represents the last quarter volution of a gigantic *Fremontoceras*, showing marked reduction of curvature in the adoral half. Whorl broad in cross section, venter conspicuously flattened, sides and dorsum rounded, 90 mm. high, 120 mm. wide. The cross section apparently retains about the same proportions to the aperture, but one

side is not preserved beyond the base. Phragmocone 150 mm. long on the curving venter, with radius of curvature 150 mm., shows only the four basal camerae clearly, averaging 25 mm. in length. Sutures straight and transverse over venter, also laterally, with faint broad shallow lobes on dorsum. Siphuncle not observed, clearly some distance from the venter, as the septa are well preserved there. The living chamber has a length of 14 inches, becoming nearly straight in the adoral half; aperture preserved only on a portion of the dorsal side, indicating growth lines transverse dorsally, sloping gradually apicad laterally to a hyponomic sinus on the venter. Living chamber increases in height from 105 mm. to 130 mm. in a dorsal length of 13 cm. and a ventral length of 23 cm. Indications are that the shell ceases to expand laterally over the adoral portion and may even decrease in width as the aperture is approached. This condition of the type may, however, be the deceptive result of slight flattening. Surface with coarse growth lines.

The shell when complete attained a diameter of eleven inches prior to the departure of the old age portion from the normal coil. A complete mature specimen including this part would measure easily 17 inches across. The aperture attained an estimated height of 15 cm. and a width which was probably equal, as there is apparently an adoral increase in shell width.

Early portions of the shell have not yet been found.

Discussion.—This large species characterizes the Terrebonne formation, highest Trenton, in the vicinity of Montreal. The holotype is the only specimen thus far encountered which is reasonably complete and well preserved; other individuals are fragments of large living chambers. Specimens are usually found with the upper side weathered and the under half missing; the holotype is exceptional; the side represented being the under side as it lay in the rock.

Having come to look upon this form as exclusively characteristic of the Terrebonne formation of the Montreal region, I was greatly perplexed to find in the collections of the Museum of Comparative Zoölogy a large extremely poorly preserved fragment, too poor for accurate specific comparison, of a form which is at least very similar in proportions and aspect, from "Trenton Falls, New York." Unfortunately, this locality, particularly on older collections is evidently to be taken in a very elastic sense. The section at Trenton Falls extends from the Denmark member of the Sherman Fall limestone into the lower Cobourg. If this specimen is actually from this section, and not farther north, where higher members of the Trenton are represented by limestones, it cannot be younger Cobourg. Elements similar to those of the Terrebonne formation are not known otherwise in this part of the section in New York though in the upper Cobourg southwest of Watertown such elements appear, including *Charactoceras*, *Westonoceras*, *Neumatoceras* and *Probillingsites*.

Fremontoceras giganteum is not uncommon in the Terrebonne near Montreal. Dr. Sinclair and I have encountered perhaps six fragmentary specimens at various localities. All except the holotype were, however, extremely poor, and all represent late portions of the shell.

Only two species of *Fremontoceras* have been previously described, *F. loperi* Foerste of the Fremont limestone of Colorado, which is also a large form, and the smaller *F. jewetti* Flower from some part of the Trenton limestone in New York. This is a smaller species, more slender, and lacks the dorsal lobes of the sutures which are found in *F. giganteum*.

Holotype.—Collection of Dr. G. Winston Sinclair.

Occurrence.—Terrebonne formation, Terrebonne, near Montreal, Quebec.

REFERENCES

BARRANDE, J., 1865–1870, Système Silurien du Centre de la Bohême, Pt. I, vol. 2, Céphalopodes. Prague.

DENIS, B. T., 1933, The Simard map area: Quebec Bureau Mines, Ann. Rep., for 1932, Part D, pp. 55–72, map.

DRESSER, J. A., 1916, Part of the district of Lake St. John, Quebec: Canada Geol. Survey, Mem. 92, 88 pp.

FLOWER, R. H., 1939, Structure and taxonomic position of *Troedssonoceras* Foerste: Jour. Paleontology, vol. 13, pp. 481–484.

——, 1939 A, Study of the Pseudorthoceratidae: Palaeontographica Americana, vol. 2, no. 10, 214 pp., 9 pls., 22 figs.

——, 1941, Notes on structure and phylogeny of eurysiphonate cephalopods: Palaeontographica Americana, vol. 3, no. 13, 56 pp., 3 pls., 3 figs.

——, 1942, An arctic cephalopod faunule from

the Cynthiana of Kentucky: Bull. Amer. Paleontology, vol. 27, no. 103, 50 pp., 4 pls.

——, 1943, An *Apsidoceras* in the Trenton of Montreal: Jour. Paleontology, vol. 17, pp. 258–263, pl. 41.

——, 1943A, New Ordovician cephalopods from eastern North America: Bull. Amer. Paleontology, vol. 28, pp. 68–82, pl. 2, 4–5 (pars), text fig. 3.

——, 1943B, Annulated orthoceraconic genera of Paleozoic nautiloids: Bull. Amer. Paleontology, vol. 28, no. 109, pp. 102–128.

——, 1946, Ordovician cephalopods of the Cincinnati region, Part I: Bull. Amer. Paleontology, no. 116, 656 pp., 50 pls., 22 figs.

——, 1947, New Ordovician nautiloids from New York: Jour. Paleontology, vol. 21, p. 429–433, pl. 59, 1 fig.

——, and KUMMEL, B., 1950, A classification of the Nautiloidea: Jour. Paleontology, vol. 24, pp. 604–616, 1 fig.

FOERSTE, A. F., 1921, Notes on arctic Ordovician and Silurian cephalopods, chiefly from Boothia Felix—King William land, Bache Peninsula and Bear Harbour: Denison Univ. Bull., Sci. Lab., Jour., vol. 19, pp. 247–306, pls. 27–35.

——, 1924, Notes on American Paleozoic cephalopods: Denison Univ. Bull., Sci. Lab., Jour., vol. 20, pp. 193–268, pls. 21–42.

——, 1928, A restudy of some of the Ordovician and Silurian cephalopods described by Hall: Denison Univ. Bull., Sci. Lab., Jour., vol. 23, pp. 173–230, pls. 40–47.

——, 1928A, A restudy of American orthoconic Silurian cephalopods: Denison Univ. Bull., Sci. Lab., Jour., vol. 23, pp. 236–320, pls. 48–75.

——, 1928B, Cephalopoda in Twenhofel, Geology of Anticosti Island: Canada Geol. Surv., Mem. 154, 480 pp., 60 pls.

——, 1928C, Some hitherto unfigured cephalopods from Anticosti Island: Royal Soc. Canada, Trans., ser. 3, vol. 22, pp. 223–234, pls. 1–11.

——, 1928D, The cephalopods of Putnam Highland: Michigan Univ., Museum of Paleontology, Contrib., vol. 3, no. 8, pp. 25–69, pls. 1–11.

——, 1932, 1933, Black River and other cephalopods from Minnesota, Wisconsin, Michigan and Ontario: Denison Univ. Bull., Sci. Lab., Jour., Part I (1932) vol. 27, pp. 47–136, pls. 7–37; Part II (1933) vol. 28, pp. 1–146.

——, 1935, Big Horn and related cephalopods: Denison Univ. Bull., Sci. Lab., Jour., vol. 30, p. 1–96, pls. 1–22.

——, 1936, The cephalopods of the Maquoketa shale of Iowa: Denison Univ. Bull., Sci. Lab., Jour., vol. 30, pp. 231–258, pls. 27–37.

GRABAU, A. W. and SHIMER, H., 1910, North American Index Fossils.

HALL, J., 1847, Palaeontology of New York, vol. 1.

HYATT, A., 1884, Genera of fossil cephalopods: Boston Soc. Nat. Hist., Proc., vol. 22, pp. 253–338.

——, 1900, Cephalopoda, in Zittel-Eastmann Textb. Paleont., vol. 2, pp. 502–604.

MANUSCRIPT RECEIVED JANUARY 20, 1951

KIRK, E., 1925, Notes on an early collection of Paleozoic fossils from Ellesmereland: Amer. Jour. Sci., ser. 5, vol. 10, pp. 445–547.

——, 1930, The Harding sandstone of Colorado: ibid., ser. 5, vol. 20, p. 456–466.

KOBAYASHI, T., 1935, Restudy of *Manchuroceras* with a brief note on the classification of endoceroids: Geol. Soc. Japan, Jour., vol. 42, pp. 736–752.

MCGERRIGLE, H., 1933, Fauna of the limestone and shale of the Simard area: Quebec Bur. Mines, Ann. Rep. for 1932, Part D, pp. 73–81.

PARKS, W. A., 1928, Faunas and stratigraphy of the Ordovician black shales and related rocks in southern Ontario: Royal Soc. Canada, Trans., 3rd ser., vol. 22, pp. 39–90, 1 pl.

RAYMOND, P. E., 1906, The Chazy formation and its fauna: Carnegie Mus., Ann., vol. 3, no. 4, pp. 498–596.

——, 1916, Report (by P. E. Raymond) on a collection of fossils from Lake St. John: In Dresser, Canada Geol. Surv., Mem. 92, pp. 38–40.

RUEDEMANN, R., 1906, Cephalopoda of the Champlain basin: New York State Museum, Bull. 90, 611 pp., 38 pls., 57 figs.

SALTER, 1856, On a new genus of Cephalopoda, *Diploceras* (*Orthoceras bisiphonatum* of Sowerby) and on the occurrence of *Ascoceras* in Britain: Quart. Jour. Geol. Soc. London, vol. 12, p. 3810.

——, 1858, On a new genus of Cephalopoda, *Tretoceras* (*Orthoceras bisiphonatum* Sowerby), and on the occurrence of the genus *Ascoceras* Barrande in Britain: ibid., vol. 14, p. 179.

SINCLAIR, G. W., 1945, An Ordovician faunule from Quebec: Canadian Field Nat., vol. 59, pp. 71–74, pl. 2.

——, 1946, Middle Ordovician trilobites from Lake St. Jean, with notes on stratigraphy (Abstract): Royal Soc. Canada, Proc., 3rd ser., vol. 40, p. 171.

TEICHERT, C., 1933, Der Bau der Actinoceroiden Cephalopoden: Palaeontographica, Bd. 678, Abt. A, pp. 111–230, pls. 8–15.

——, 1934, Untersuchungen an actinoceroiden Cephalopoden aus Nordgrönland: Meddelelser om Grønland, Bd. 92, nr. 10, pp. 1–48, 22 figs.

TROEDSSON, G., 1926, On the middle and upper Ordovician faunas of northern Greenland. I. Cephalopods: Meddelelser om Grønland, Bd. 71, pp. 1–157, pls. 1–65.

——, 1932, Studies on Baltic fossil cephalopods. II. Vertically striated or fluted orthoceracones in the *Orthoceras* limestone. 38 pp., 7 pls.

——, 1937, On the Cambro-Ordovician faunas of western Quruq Tagh eastern T'ien Shan: Paleontologica Sinica, n.s. B, no. 2, Whole Ser. no. 106, 74 pp., 10 pls.

ULRICH, E. O., and FOERSTE, A. F., 1936, New genera of Ozarkian and Canadian cephalopods: Denison Univ. Bull., Sci. Lab., Jour., vol. 30, pp. 259–290, pl. 38.

——, FOERSTE A. F., MILLER, A. K., and UNKLESBAY, A. G., 1944, Ozarkian and Canadian cephalopods. Part III: Longicones: Geol. Soc. America, Special Paper 58, 225 pp., 68 pls.

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A *NERINEA* FROM SOUTHWESTERN ORIENTE PROVINCE, CUBA

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ABSTRACT—Loose specimens of a new species of *Nerinea*, *N. epelys*, were found in an outcrop area of limestone of middle Eocene age in southwestern Oriente Province, Cuba. They are presumed to be Upper Cretaceous detrital constituents weathered out of the Eocene limestone. *N. epelys* is closely allied to the Upper Cretaceous European *N. bicincta*; indeed, specimens of the Cuban species from the Upper Cretaceous Habana formation of Camaguey Province were identified by Knipscheer as *N. bicincta*.

THE *Nerinea* herewith described was collected during the course of geologic mapping in southwestern Oriente Province, Cuba, in the foothills of the Sierra Maestra about 20 kilometers south-southeast of Bayamo. More specifically the locality is on the south side of Río Guamá on Finca Entre Ríos, the estate of the soldier and statesman General Carlos García Veles, a son of the Cuban general and patriot Calixto García Iñiguez, immortalized in Elbert Hubbard's "A Message to Garcia." I was guided to the fossils by a son of the estate owner, Sr. Calixto García Martínez Ibor, who had noticed them in a cultivated field. The fossil locality is recorded as locality 11 in a report on the geology of the Guisa-Los Negros area and is shown on the geologic map accompanying that report (Woodring and Daviess, 1944, p. 373, pl. 68).

The locality is in an outcrop area of the Charco Redondo limestone, of Eocene age. Though that formation was assigned to the upper Eocene by Woodring and Daviess, a middle Eocene age is preferred by micropaleontologists (Bermúdez, 1950, p. 246, correlation table)—and, aside from calcareous algae, Foraminifera are by far the most abundant fossils in the Charco Redondo limestone, as well as in the underlying formation and the overlying formation. The fossils, however, were weathered out of their matrix and were lying loose in the field. A low cliff of limestone of the Charco Redondo rises along the south border of the field less than 100 meters from the scattered spots where the fossils were found. A float piece of *Nerinea*-bearing limestone was observed, but unfortunately not collected, closer to the foot of the cliff, but no mollusks were seen in the cliff-forming limestone. No exhaustive search, however, was made; and other observations that would now be pertinent were not considered, for it was not suspected that both Cretaceous and Eocene fossils were being picked up.

When the *Nerinea* was collected it was thought to represent a *Campanile*-like large cerithid, and its affinities were not realized until specimens were sectioned in Washington. At that time the matter was not pursued further than to list it as an unidentified nerineid genus. It is, of course, as shocking to find an Eocene nerineid as to find an Eocene ammonite. Nerineids reached their acme in the Jurassic and early Cretaceous, rapidly declined in the late Cretaceous, and disappeared before the close of Cretaceous time. To be sure, Chavan (1946) recently suggested that the Eocene cerithid genus *Bezançonia* is to be assigned to the Nerineidae. *Bezançonia*, however, has no labral or

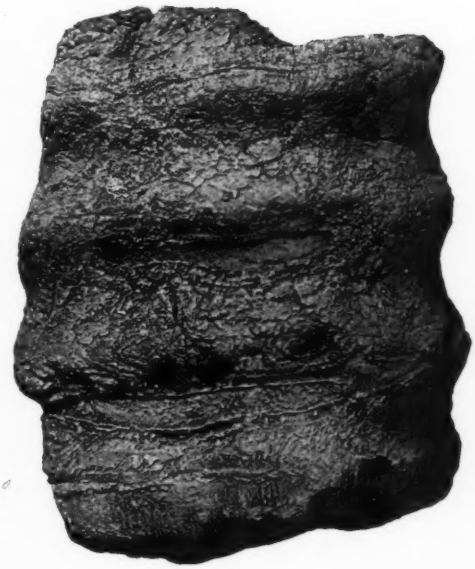
EXPLANATION OF PLATE 11

The specimens illustrated on this plate were found at U. S. Geol. Survey locality 15252, on Finca Entre Ríos, about 20 kilometers south-southeast of Bayamo, Oriente Province, Cuba; in outcrop area of middle Eocene Charco Redondo limestone, but presumably derived from Upper Cretaceous Habana formation or its equivalent.

FIGS. *1, 1a*—*Nerinea epelys* Woodring, n. sp. Type, ×1. U. S. Nat. Mus. 560624.
2, 2a—*Nerinea epelys* Woodring, n. sp., ×1. U. S. Nat. Mus. 560625.

1

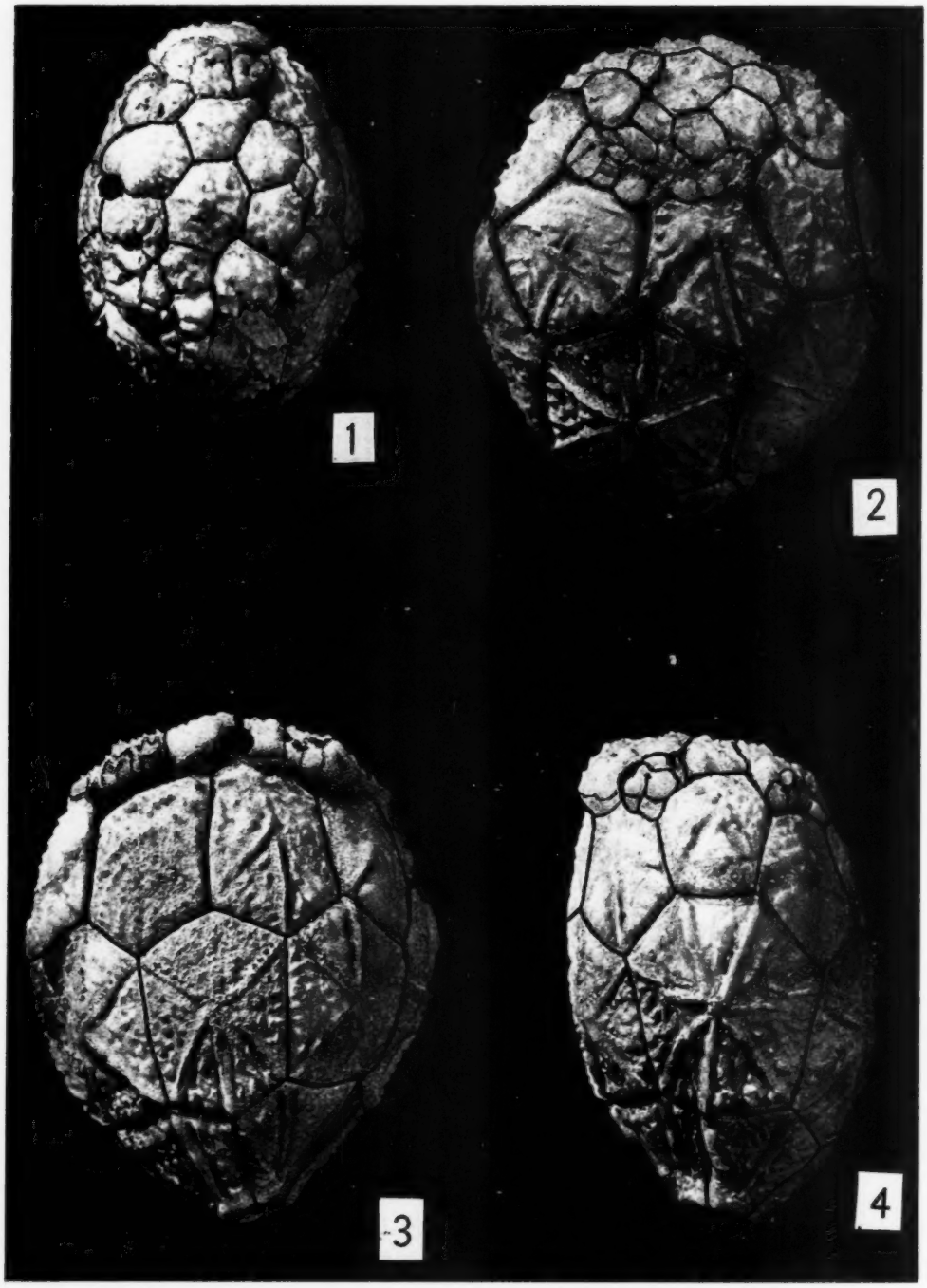
1a



2

2a

Woodring, *Nerinea* from Cuba



Strimple, new Tennessee Silurian cystoid

parietal folds. It is improbable that the *Nerinea* is a genuine Eocene fossil.

Three other species of mollusks were found in the field. They were recorded, in preliminary identification, as *Terebralia?* sp., *Mitreola?* cf. *labratula* (Lamarck), and *Corbis* cf. *claibornensis* Dall (Woodring and Daviesss, 1944, p. 373). The preliminary identification of two of these species is erroneous. H. B. Stenzel has pointed out that the cerithid ("*Terebralia?*") is related to the middle Eocene Texan "*Cerithium*" *vinctum* Whitfield, allied forms of which are found in the Eocene of Jamaica and Panama. J. B. Reeside, Jr., informs me that the two imperfect gastropods listed as *Mitreola?* cf. *labratula* represent an *Actaeonella* of the subgenus *Trochactaeon*, known only from the Cretaceous. The "*Cerithium*" and the *Corbis*, both of which are expectable Eocene fossils, are light-colored and silicified—and the *Corbis* has adhering matrix of partly silicified light gray limestone—whereas the specimens of *Nerinea* and of *Actaeonella* are dark-colored and not silicified. There is therefore an objective basis for classifying the fossils in two groups on preservation and that classification agrees with a classification based on what is known about their range in time.

The *Nerinea* and the *Actaeonella* are presumed to be Upper Cretaceous detrital constituents weathered out of the Charco Redondo limestone. The presumption is afforded some measure of justification by the occurrence of the same *Nerinea* in the Upper Cretaceous Habana formation of Camaguey Province, about 150 kilometers northwest of the Oriente locality, as recorded by Knipscheer (1938, p. 673), a record that was overlooked when the report on the Guisa-Los Negros area was prepared. The nearest known fossiliferous Upper Cretaceous deposits in Oriente are in the east-central part of the province about 100 kilometers east-northeast of Bayamo, in the area covered by Lewis and Straczek in a forthcoming report. *Nerinea*, however, so far has not been found in them. Fossiliferous Upper Cretaceous deposits presumably shed debris into the Charco Redondo sea. The Charco Redondo limestone is underlain by the Paleocene to middle Eocene Cobre formation,[1] which is estimated to have a thickness of several thousand meters. Under the presumption just specified, the Charco Redondo limestone, or an equivalent part of the Cobre formation, overlapped across several thousand meters of Eocene and Paleocene deposits. It would not be profitable at the present time to speculate concerning an alternative possibility: that Río Bayamo, into which Río Guamá empties near the fossil locality, drains a still unknown area of fossiliferous Upper Cretaceous strata in the central part of the western Sierra Maestra, and that the Upper Cretaceous fossils represent lag constituents of a former alluvial deposit of that stream. So far as known the much shorter Río Guamá drains only areas underlain by the Charco Redondo limestone and the Cobre formation.

DESCRIPTION OF SPECIES

Family NERINEIDAE

Genus NERINEA Deshayes

Subgenus NERINEA s. s.

DESHAYES, 1827, Dict. Classique Hist. Nat., vol. 11, p. 534.

Type (monotype): *Nerinea mosae* Deshayes (*Nerina* in species name, presumably typographic error), middle Upper Jurassic (Corallian), France.

NERINEA EPELYS Woodring, n. sp.

Plate 11

Nerinea bicincta Bronn, KNIPSCHEER, 1938, p. 673, figs. 1, 2, 3*a–c*.

Nerineid, genus?, WOODRING & DAVIESS, 1944, p. 378, list.

Large, elongate conic. Apex blunt (worn?), early whorls rapidly enlarging, subsequent whorls slowly enlarging. Body whorl sculptured with a wide sutural band, which

[1] The Cobre formation is considered Paleocene and lower Eocene by Bermúdez (1950, p. 239, correlation table), but, according to de Albear (in Lewis and Straczek, unpublished), the upper part of the formation contains Foraminifera of middle Eocene age. The upper part of the Cobre —the only part exposed in the Guisa-Los Negros area—was referred to the upper Eocene on inadequate grounds by Woodring and Daviess (1944, p. 367).

For explanation of Plate 12 please turn to page 64.

conceals suture, and a similar basal band. Both bands bearing wide crude nodes, 11 or 12 to a whorl on later whorls. More or less well-defined low crude axials extend from nodes across body and spire whorls, but are subdued on middle of whorls. Sutural band only, with its nodes and corresponding axials, exposed on spire whorls. Interior bearing two short subequal columellar folds, a short oblique parietal fold, and a moderately long wide-based labral fold. Aperture and growth line unknown.

Height (incomplete, 6 whorls) 87 mm., diameter 47 mm. (type). Height (incomplete, 4 whorls) 62 mm., diameter 55 mm. (figured specimen).

Type.—U. S. Nat. Mus. 560624.

Type locality.—U. S. Geol. Survey locality 15252 (Cenozoic invertebrate register), Finca Entre Ríos, slope on south side of Río Guamá, 2 kilometers southeast of Tienda Nueva at El Corojo and about 20 kilometers south-southeast of Bayamo, Oriente Province. Four incomplete specimens. In outcrop area of middle Eocene Charco Redondo limestone, but presumably derived from Upper Cretaceous (Maestrichtian and Campanian (?), according to Imlay, 1944, p. 1015) Habana formation or its equivalent.

Other localities.—About 700 meters south of Aurora, and Cantera Caballero west of Sibanicú, both in Camaguey Province; Habana formation (Knipscheer, 1938, p. 673, as *N. bicincta* Bronn).

Remarks.—The large figured specimen and, to a lesser extent, the type are somewhat corroded. A large, but incomplete, specimen, larger than any found by the U. S. Geological Survey party, was collected at the same locality at an earlier date by Sr. Calixto García Martínez Ibor and presented to Ing. Antonio Calvache, Consulting Engineer of the Dirección de Montes, Minas y Aguas.

Nerinea epelys was identified by Knipscheer as the Upper Cretaceous European *N. bicincta* Bronn (1836, p. 562, pl. 6, fig. 14), from the Gosau beds of Austria, of Turonian and Senonian age. Bronn's illustration is too generalized to afford a basis for comparison. According to Zekeli's (1852, p. 34, pl. 4, figs. 3, 4, not fig. 5; as *N. buchi* "(Keferstein) Zekeli") and Goldfuss' (1862–66, pt. 3, 1863, p. 44, pl. 177, figs. 5*a*, *b*) illustrations, *N. bicincta* lacks the strong sutural band of *N. epelys* and has narrower nodes and axials. Nevertheless the two species are closely allied: the folds have the same plan and the sculptural pattern is similar. There appear to be no similar American species; in fact, *Nerinea* is very rare in the Upper Cretaceous of America. The fold and sculptural patterns suggest assignment to the subgenus *Nerinea* s. s.

The earliest formal proposal of the generic name *Nerinea* has been discussed recently by Cox (1949).

REFERENCES

Bermúdez, P. J., 1950, Contribución al estudio del Cenozoico Cubano: Soc. Cubana Hist. Nat. Felipe Poey Mem., vol. 19, pp. 205–375.

Bronn, H. G., 1836, Übersicht und Abbildungen der bis jetzt bekannten *Nerinea*-Arten: Neues Jahrb., 1836, pp. 545–566, pl. 6.

Chavan, A., 1946, Sur la position systématique du genre *Bezançonia:* Soc. Géol. France, Compte Rendu Som., no. 2, pp. 22–24, 1946.

Cox, L. R., 1949, On the genotype of *Nerinea*, with a new subgeneric name *Eunerinea:* Malacological Soc. London Proc., vol. 27, pp. 248–250.

Goldfuss, August, 1862–66, Petrefacta Germaniae, 2d ed., 4 pts. (separately paginated), 199 pls.

Imlay, R. W., 1944, Correlation of the Cretaceous formations of the Greater Antilles, Central America, and Mexico: Geol. Soc. America Bull., vol. 55, pp. 1005–1045, 2 pls., 1 fig., chart.

Knipscheer, H., 1938, On Cretaceous Nerineas from Cuba: K. Akad. Wetensch. Amsterdam Proc., vol. 41, no. 6, pp. 673–676, 15 figs.

Lewis, G. E., and Straczek, J. A., Geology of south-central Oriente Province, Cuba: U. S. Geol. Survey Bull. (in preparation).

Woodring, W. P., and Daviess, S. N., 1944, Geology and manganese deposits of Guisa-Los Negros area, Oriente Province, Cuba: U. S. Geol. Survey Bull. 935, pp. 357–386, pls. 68–77, figs. 19, 20.

Zekeli, Friedrich, 1852, Die Gasteropoden der Gosaugebilde: K. k. Geol. Reichsanstalt Abh., vol. 1, pt. 2, no. 2, 124 pp., 24 pls.

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JOURNAL OF PALEONTOLOGY, VOL. 26, NO. 1, PP. 63–64, PL. 12, 1 TEXT-FIGURE, JANUARY 1952

A NEW CYSTOID FROM THE DIXON FORMATION

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INTRODUCTION

THE red clays and limestones of the Dixon formation of Tennessee have not been closely examined for echinoderms due to the richly fossiliferous nature of the overlying Brownsport formation. Dr. A. R. Loeblich, Jr., of the U. S. National Museum, has recently collected several echinoderms, one of which is described here as *Caryocrinites marginis*, n. sp.

DESCRIPTION OF SPECIES

Genus CARYOCRINITES Say, 1825

CARYOCRINITES MARGINIS
Strimple, n. sp.
Plate 12, figures 1–4, text-figure 1

Description.—Theca is high, semiglobose shaped. The position of the anal opening is taken to be posterior. When the theca is viewed from either the right or left side it is seen to curve to the posterior, particularly in the infrabasal (IBB) area.

There are four IBB which rise evenly from the columnar scar. R. post. and l. post. IBB are apparently fused plates, each supporting a basal plate (B) without assistance of other IBB, and participate in the support of adjoining BB, both to the right and left. Two divergent, sharp ridges extend the length of each plate to the distal apices. In addition, the l. post. IB has a ray extending to the termination of the left lateral side. The two anterior IBB are pentagonal and each has one strong ray extending the length of the plate, with two less pronounced divergent ridges terminating at the distal extremities of the lateral sides.

Six basals (BB) are present. Post. B is elongate, hexagonal and both of the BB to the right and left are pentagonal. These three BB of the posterior are smaller than the other BB. Ant. B is hexagonal and both of the BB to the right and left have truncated distal extremities for support of interradials (IRR). Sharp rays diverge from the umbo to the angles of each plate.

Eight plates are present in the radial (RR) circlet, two of which are considered to be interradials. The RR to the right and left of posterior are pentagonal and are almost identical in appearance. There are three more or less pronounced rays diverging from highly placed umbones to the proximal angles of the plates. That to the left bears four brachials (two articulating facets), the one to the right two brachials (one articulating facet) and a portion of another brachial to the right. The next RR to the right and left are pentagonal with light rays from the

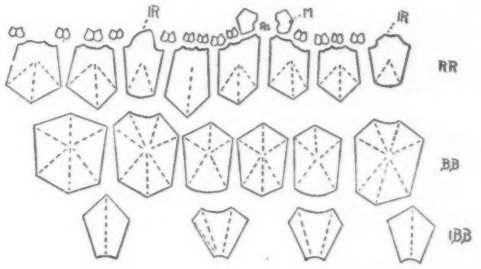

FIG. 1—*Caryocrinites marginis* Strimple, n. sp. Diagrammatic sketch showing the structure and arrangement of the body plates and position of the brachials. Infrabasals are designated by IBB, basals by BB, radials by RR, interradial by IR, anal opening by As and the hydropore by M. Broken lines indicate the position of the principal ridges.

umbos to the lower angles of the plates. Both have two brachials (one articulating facet) and portions of brachials on each shoulder. The right IR is hexagonal and has light rays from umbo to the two proximal angles. It is in direct contact with a plate of the tegmen and assists in the support of arms on both the right and left shoulders. The left IR is pentagonal, but in other respects is indentical to the right IR. Right and left anterior RR are pentagonal and each is marked by three rays from umbo to lower angles of the plate. The l. ant. R has two brachials (one articulating facet) and most of another facet to the left. The r. ant.

R has two brachials (one articulating facet) and assists in support of brachials to the right.

The tegmen is primarily composed of seven moderately large plates surrounding a large, centrally located plate. The anal opening is between the two posterior tegmenal plates and another smaller opening (? hydropore) is found in the upper right lateral side of the right posterior plate. Radiating ridges are present on each plate, and are normally met by similar processes on adjoining plates. These ridges are not quite so pronounced as those found on the lateral sides of the theca. In addition to the large plates, a small plate is found above each pair of brachials, and another (six in all) above each cluster of brachials.

Additional ornamentation consists of numerous sharp ridges which are normally broken up due to the cross trends in endeavor to follow the main ridges. Small granules provide additional ornate appearance.

The only pores observed occur along the upper sides of the laterally directed major rays of the radial plates and along both sides of the central rays above the umbos. Each pore is marked by a small raised, node-like process, and as many as nine are present along one side of a ridge.

The columnar scar is round, lightly crenulated about the perimeter, and is pierced by a large, quadrilobate lumen.

Measurements	*Holotype* Mm.
Over-all height of theca	40.6
Maximum width of theca	34.7
Height of IBB circlet	8.7
Width of IBB circlet	19.7
Width of columnar scar	5.1

Remarks.—This species is more closely related to *C. ornatus* Say than to other described species. However, it is larger than normal representatives of that species and is readily separable from it and other species due to its spectacular ornamentation.

Occurrence and horizon.—Dixon formation, Silurian; on Pitts Hollow road 0.8 mile south of junction of Pitts Hollow road with U. S. Highway 64, south-central rectangle on Eagle Creek Quadrangle, TVA 33 SW Tennessee.

Holotype.—Collected by Dr. A. R. Loeblich, Jr. Deposited in the U. S. National Museum.

MANUSCRIPT RECEIVED JANUARY 19, 1951.

EXPLANATION OF PLATE 12 (FACING PAGE 61)

For orientation the anal opening is taken as posterior.

FIGS. *1–4*—*Caryocrinites marginis* Strimple, n. sp. Holotype viewed from summit (anal opening to the left), oblique anterior, posterior, and right side (right interradial at summit of theca, in contact with tegmen plate), ×1.7.

JOURNAL OF PALEONTOLOGY, VOL. 26, NO. 1, PP. 65–73, PLS. 13–16, JANUARY 1952

SOME ZONE MARKER FOSSILS OF THE GLEN ROSE FORMATION OF CENTRAL TEXAS

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ABSTRACT—Included are descriptions of 13 new species of pelecypods and gastropods characteristic of the transition zone between the lower and upper Glen Rose formation of the Comanche of Texas. Most important in this group is the small *Corbula* that occurs in a thin bed, which can be used as a shore-line marker over a wide area of the outcrop. Above this bed lithology and fauna change.

INTRODUCTION

THE Glen Rose formation is predominantly a sequence of limestone beds belonging to the Trinity group of the Comanche series of Texas. At its outcrop in central Texas, where most of the fossils described in this paper were collected, it is 740 feet thick. In north-central Texas about 16 miles northwest of Fort Worth, Texas it is about 10 feet thick. The formation thickens southwestward from central Texas, and was said by C. L. Baker (personal communication) to be several thousand feet thick in Mexico. Throughout most of the formation there is an alternation of hard and soft limestones. The basal portion consists largely of massive limestone, whereas the upper portion tends chiefly to be thin-bedded hard limestones alternating with thin-bedded soft limestones, the latter breaking down upon weathering into clays and shaley limestones. These are known as the alternating beds. They give rise to the very characteristic terraced hill topography of central Texas.

During the construction of the Mansfield dam on the Colorado River, three-foot cores were cut through more than 90 feet of the Glen Rose formation at the dam site. These showed the predominantly limestone character of the formation, but after about three months of weathering, sections of the cores began to break down into incoherent marly material like the softer beds along the outcrops.

In addition to the limestone and the marl there are several sand and anhydrite beds. There is sandstone in the basal portion of the formation and also in Comal County the upper 60 feet is quite sandy.

Not only does the general lithologic character of the upper Glen Rose differ from that of the lower, but the fauna also seems to be quite different. The alternating beds have fewer fossils than the lower limestones, but there are many lower beds barren of fossils, while others are highly fossiliferous. Preservation is usually in the form of casts.

Despite the fact that the Glen Rose is one of the most widespread and probably the thickest Cretaceous formation in central and southwest Texas very little has been published on it. Dr. F. L. Whitney, who collected the fossils described in this paper, has done extensive research on the Glen Rose, but has not yet published his findings. Several geologists have described a few fossils from the Glen Rose, but the vast majority of the fossils remain undescribed. In studying the extensive collections made in several central Texas counties by Dr. Whitney, I have found about 140 new species. It is the purpose of this paper to describe a few of the new species which are good zone markers.

At Austin, Texas, 275 feet above the base of the Glen Rose formation, is found *Salenia texana* Credner in a zone about 2 feet thick. Everywhere throughout central Texas this species seems to be restricted to this narrow and highly fossiliferous zone. Above the *Salenia texana* bed there are about 5 feet of marly material carrying a rather large assemblage of characteristic forms. Capping this is a bed about 1 foot thick containing tiny *Corbula* shells. This is one of the most distinctive zones in the Glen Rose formation. Nearly the entire rock in this horizon is made up of *Corbula* shells packed tightly together. This bed has been found in many places in Bandera, Comal, Hays, Travis,

and Blanco Counties and is perhaps the most useful horizon marker in the formation. This whole fossiliferous zone from the bottom of the *Salenia texana* bed to the top of the *Corbula* bed is normally about 8 feet thick and is referred to by F. L. Whitney as the *Salenia texana* horizon. Not only is this horizon useful to the stratigrapher, but it marks the transition point between the fauna of basal Glen Rose and that of the upper Glen Rose and, hence is of interest to the paleontologist. Many species characteristic of the lower Glen Rose do not cross this horizon into the upper part of the formation. Above the *Corbula* bed species are found which have not been reported from the basal Glen Rose. Within the horizon itself over 30 new species have been collected. It is the purpose of this paper to describe a few of the most characteristic species of this zone, and it is the intention of the writer to describe additional species at a later date.

Some geologists have believed that the Glen Rose is the equivalent of the Aptian of Europe and that the Albian began at the close of Glen Rose time. Dr. Gayle Scott (personal communication) believed that the whole of the Glen Rose was Albian on the basis of the cephalopods contained in the formation. There are many pelecypod and gastropod species, however, in the lower Glen Rose, which do not extend beyond the *Salenia texana* horizon and which bear close resemblance to similar species from the Aptian of Europe.

The type specimens here described are deposited in the museum of the University of Texas at Austin.

SYSTEMATIC PART

Family CORBULIDAE Fleming

Genus CORBULA Lamarck

CORBULA MARTINAE Whitney, n. sp.

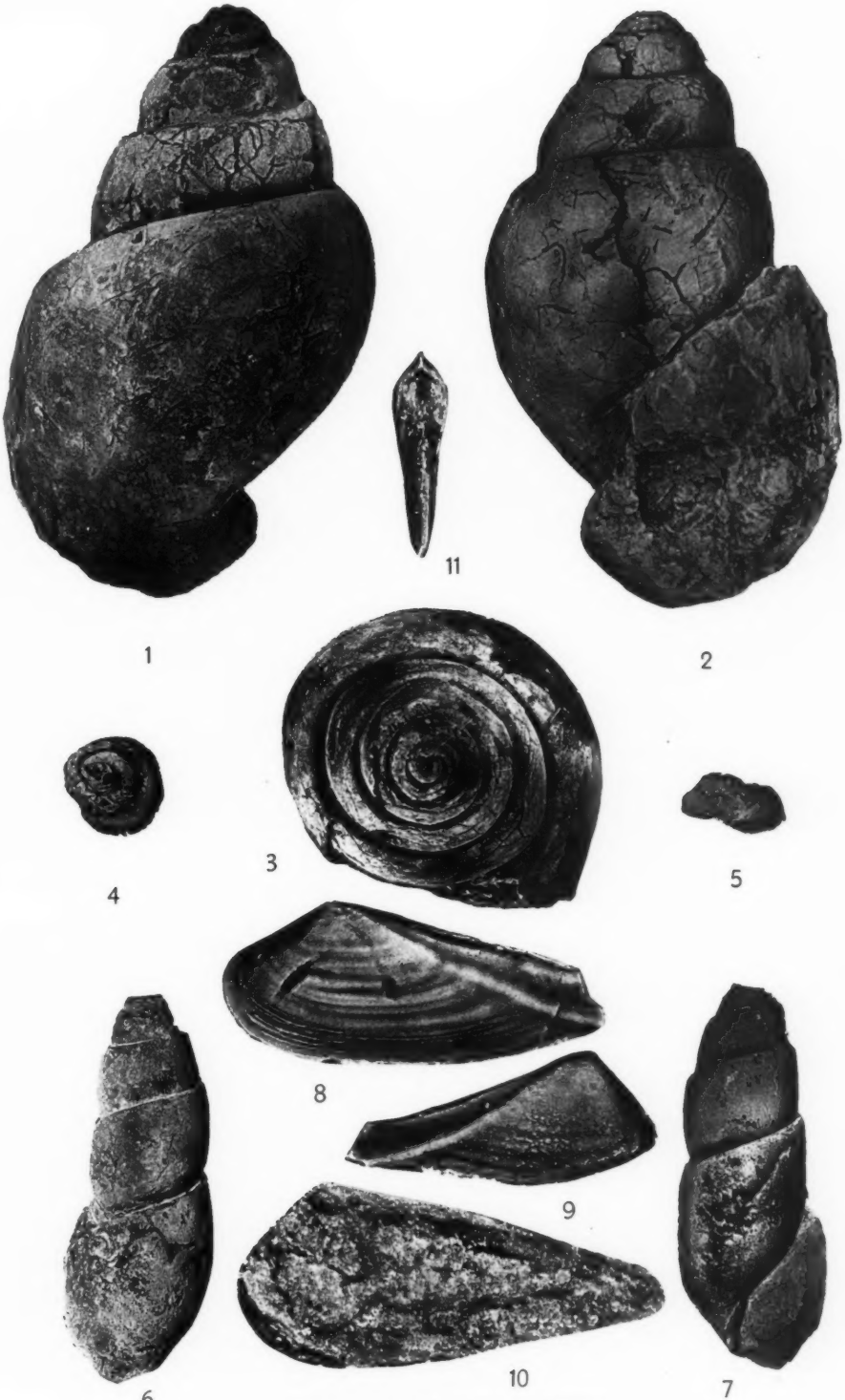
Plate 13, figures 8–11

Shell very small, from 3 to 9 mm. in length, very elongate, inequilateral, and inequivalve, the right valve being slightly larger than the left valve. This does not show where only the cast is preserved, but in the cases where the shell has been preserved it is very evident. The beaks are small, anterior, close together, incurved, pointed, directed anteriorly, prominent, and nearly terminal. The hinge shows distinct bending between the beaks. From the right valve just posterior to the beak there is a tongue-shaped projection which extends anteriorly and obliquely toward the opposite valve and terminates at the hinge. On either side of this projection there is a deep depression, and in the center there is a longitudinal groove. Right valve equipped with one large tooth, which usually can not be found.

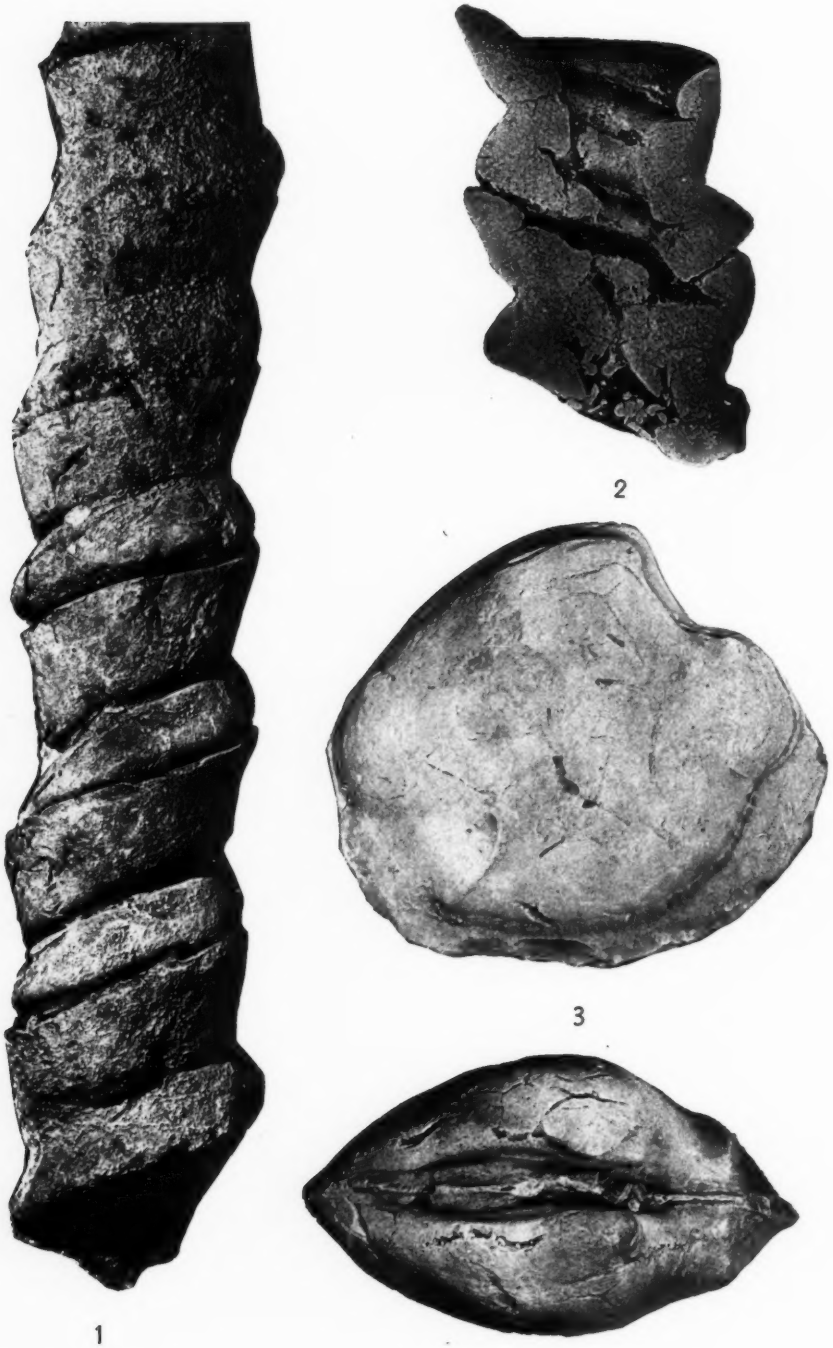
Posterior cardinal margin very long, sloping, and concave; accompanied in the lower extremity by a strong, narrow, rounded ridge which increases in width toward the posterior and decreases toward the anterior end. The anterior cardinal margin is short and concave. The anterior margin is very narrowly rounded. The ventral margin is long, curved at the extreme anterior end, but straightens out in some specimens and remains very slightly arcuate in others; frequently it is concave close to the posterior end. Posterior margin very attenuated and pointed. Possibly it is slightly gaping. Between the umbonal ridge and the ridge on the cardinal margin the shell is very narrow on the posterior end and usually very slightly notched. The umbonal ridge is long, oblique, and very gently curved downward in the middle. It extends from the umbones to the posteroventral angle. Between this ridge and the one along the cardinal margin there is a long depression which widens toward the posterior end, because the two ridges are slightly diverging. The sides are gently convex, flattening somewhat toward the posterior. The greatest thickness is be-

EXPLANATION OF PLATE 13

FIGS. *1–3—Tylostoma travisensis* Whitney, n. sp., lateral, apertural and end views, ×1. (p. 72)
4, 5—Pleurotomaria glenrosensis Whitney, n. sp., end and apertural views, ×1. (p. 72)
6, 7—Strombus beckleyi Whitney, n. sp., lateral and apertural views, ×1. (p. 72)
8–10—Corbula martinae Whitney, n. sp.; *8*, lateral view, right valve, holotype; *9*, lateral view view left valve, syntype; *10*, interior view showing tooth, syntype; *11*, dorsal view, syntype. All ×6. (p. 66)



Whitney, Glen Rose fauna



1 2 3 4

Whitney, Glen Rose fauna

low the beaks, and the greatest height is at the beaks. The anterior end is thickened, but the posterior end is thin.

The pallial line is deep, long, entire, curved at the anterior end, straight along the ventral side, ending abruptly at the umbonal ridge. It is also quite high above the ventral margin. There are no muscle scars visible.

The exterior is marked by fine lines near the ventral margin. These lines do not often appear above the transverse mid-line and are curved on the anterior portion and end abruptly at the umbonal ridge. In the casts several coarse ridges can be seen on the sides.

Corbula martinae very closely resembles *C. picteti* (Recueil d'Études Paléontologiques Sur La Faune Crétacique du Portugal, vol. 1, Paul Choffat, 1883, p. 25, figs. 1–4). The lines on the sides are considerably finer and closer together, however, in the species from the Glen Rose. *C. picteti* is found in the Bellasian of Portugal which is in reality in the Albian and Cenomanian of Europe according to Haug (Traité de Geologie pt. 11, p. 1277). Since these forms appear to be closely related it is probable that they correspond in age also. Thus the presence of *C. martinae* along with other species related to Albian forms suggests that the equivalent of the Albian begins in the Glen Rose at this horizon 280 feet above the base of the formation as determined by core drilling at the Mansfield Dam site on the Colorado River.

Corbula martinae is very abundant in a constricted horizon 12 to 15 inches thick. It is an important horizon marker because it is so restricted. Nearly the entire bed is often made up of this species. It is so small that one slab of limestone an inch thick and only a few inches square contains thousands of specimens. To the naked eye they resemble a thick sprinkling of grains of wheat scattered upon the surface of the rock; but to examine them, the lens is necessary.

Dimensions: height 3 mm., length 7 mm., width 1 mm.

Occurrence.—Several outcrops in Blanco, Travis, Hays, and Comal counties of Texas. In Travis County, it is found at Lohmann Ford on Colorado River and on both sides of the valley of Sandy Creek. It is also found in the cores taken at the site of the Mansfield dam on the Colorado River about 275 feet above the base of the Glen Rose. In Comal County it is about 284 feet above the base of the Glen Rose.

Type locality.—About 2½ miles south of Lone Man Mt., Hays Co., Texas on Dripping Springs-Wimberly road.

Family POROMYACIDAE Dall
Genus LIOPISTHA Meek
LIOPISTHA (PSILOMYA) BANDERAENSIS
Whitney, n. sp.
Plate 16, figures 1, 2

Cast large, equivalve, inequilateral, high at the umbones, roughly triangular. Beaks bluntly pointed at the tip, greatly incurved near the anterior end, directed slightly toward the anterior. Umbones large, prominent, ventricose. Hinge slightly arched and possessing two teeth in each valve. The teeth in both valves are nearly horizontal and inequal. In the right valve the anterior tooth is quite wide but smaller than the posterior tooth which is large, wide and sloping. In the left valve the anterior tooth is conical and long. Posterior to this tooth is a deep, triangular fossette. The posterior tooth is rudimentary and oblique—directed anteriorly. Posterior cardinal margin long, gently sloping. Anterior cardinal margin very short and sloping. Anterior margin straight, sloping obliquely outward, bending abruptly toward the ventral margin at the lower portion of the muscle scar. Anterior end of the shell quite thick. Buccal slopes long, narrow, crescentic, almost vertical, ending at the muscle scar. Anterior umbonal ridge fairly sharp, narrow, low, ending also at the muscle scar. Ventral margin quite thin, curved at the ends and straight in the

EXPLANATION OF PLATE 14

FIGS. 1, 2—*Nerinea roemeri* Whitney, n. sp. *1*, lateral view, holotype; *2*, cross section showing plaits, syntype. Both ×1. (p. 71)

3, 4—*Meretrix hanseni* Whitney, n. sp., lateral and dorsal views, ×1. (p. 69)

middle. Posterior margin rounded at the ventral end but nearly straight above, very sloping, high, and slightly gaping. The posterior end is thin. Postumbonal ridge wide, rounded, long and oblique. Postumbonal slope wide throughout its length.

Anterior muscle scar very large, rounded on the ventral side, truncated on all other sides, raised, prolonged in a small point extending up the buccal margin, marked by several crescentic ridges. The scar is located quite near the ventral side. Posterior muscle scar nearly circular but flattened on top, placed obliquely on the upper umbonal slope near the umbonal margin, raised, marked by concentric rings. Pallial line distinctly marked by a wide, flat ridge on either side of which is a narrow, shallow groove with beaded edges. The pallial line is not parallel to the ventral margin but is high at the anterior muscle scar and slopes down toward the ventral margin in the posterior portion of the shell. At the postumbonal ridge it turns abruptly with a broad, rounded angle and follows up the umbonal ridge to the posterior muscle scar.

The surface of the shell does not present any markings. The sides are flattened. The umbones are rounded and thick. The highest portion of the shell is at the beaks and the thickest part is near the upper portion of the umbones.

Dimensions: height 90 mm., length in the ventral portion 100 mm., width 55 mm.

Type locality.—Salenia texana horizon nearly 1 mile east of Bandera, Tex.

LIOPISTHA (PSILOMYA) WALKERI
Whitney, n. sp.
Plate 16, figures 5, 6

Cast large, ventricose, wedge-shaped, equivalve, inequilateral. Beaks very terminal, inrolled, pointed, directed forward. Umbones large, inflated. Hinge with two teeth in each valve. In the right valve the posterior tooth is flattened and lower than the conical, anterior tooth. In the left valve the anterior tooth is large, while the posterior tooth is small and rudimentary. There is a fossette between these teeth. Posterior cardinal margin fairly long, straight and directed slightly upward. Anterior cardinal margin carinate, rounded, steeply sloping and short. Anterior margin very short and rounded. Ventral margin strongly arcuate. The posterior margin is bluntly rounded near the ventral side, but from the middle of the posterior side it rises in a straight, steeply sloping line to the high posterior cardinal margin. Umbonal ridge very prominent, high, wide, and straight. Postumbonal slope wide and concave. Posterior end is gaping but thinner than the rest of the shell. Anterior end wide but narrower than the very inflated and oblique umbonal region. Greatest height half an inch posterior to the beaks. Greatest width on the umbones near the posterior end.

The pallial line is entire, practically parallel to the ventral margin, slightly curved upward to the anterior muscle scar, but gently arcuate along its ventral extent. At the posterior end it makes a very sharp bend and extends obliquely up the umbonal ridge to the large, round, raised posterior muscle scar high on the posterior umbonal slope. The anterior muscle scar is also large and rounded with a small projection directed upward along the anterior cardinal margin. The scar is situated very near the anteroventral angle. No exterior ornamentation is apparent on the cast.

Liopistha walkeri resembles *L. jurafacies* in general outline, but its beaks are more terminal, its posterior cardinal margin and its posterior margin higher and differently shaped.

Dimensions: height 65 mm., slightly posterior to the beaks; length 95 mm.; width 70 mm.

Type locality.—Salenia texana horizon of the Glen Rose at Bandera, Tex.

LIOPISTHA (PSILOMYA) FLETCHERI
Whitney, n. sp.
Plate 16, figures 3, 4

Cast large, ventricose, equivalve, inequilateral, high on the anterior end, elongate, high, directed slightly forward. Umbones narrowed on top, quite convex. Hinge with two nearly horizontal teeth in each valve. On the right valve the anterior tooth is high, conical, pointed and slightly twisted. The posterior tooth is inferior and pointed. On the left valve the anterior tooth is large, directed anteriorly. The posterior tooth is rudimentary and directed posteriorly. There is a fossette between. The posterior cardinal

margin is long and slightly concave. The anterior cardinal margin is short and steeply sloping. Anterior margin very short and rounded. Anterior end of shell greatly inflated. Ventral margin long and strongly curved, carinate at the edge. Posterior margin bluntly rounded, high at the juncture with the umbonal margin. Posterior end of shell flared, gaping but quite constricted back of the margins. Middle portion of the shell inflated; thickest portion high on the umbones. The highest part of the shell is at the beaks. The umbonal ridge is not pronounced. The postumbonal slope is wide and concave. No surface markings are present on the cast. The muscle scars and pallial line are not visible on the material at hand.

Liopistha (*Psilomya*) *fletcheri* differs from *L. solida* Cragin chiefly in having a more prolonged posterior, a concave posterior cardinal margin and a more rounded ventral margin. It shows some resemblance to *L. gigantea* Sow. (1909, p. 43, figs. 3, 4; pl. 44, figs. 1, 2) but *L. fletcheri* does not have a straight posterior cardinal margin. The ventral margin swings up higher to meet the posterior margin and the posterior end is not similar to that of *L. gigantea* Sow.

L. fletcheri was found by Mr. Claude Fletcher.

Dimensions: height 75 mm., length 95 mm., width 55 mm.

Type locality.—Salenia texana horizon of the Glen Rose formation at Julian Creek, Bandera, Texas.

Family VENERIDAE Leach
Genus MERETRIX Lamarck
MERETRIX HANSENI Whitney, n. sp.
Plate 14, figures 3, 4

Cast large, high, ventricose, suboval, equivalve, inequilateral. Beaks high, pointed, close together, subcentral, directed anteriorly, convex on the posterior side, concave on the anterior side. Hinge arcuate, presenting the impressions of two teeth in each valve. Posterior cardinal margin long, arcuate, very sloping, evenly curved to the tip of the beaks. Anterior cardinal margin concave, short. Anterior and posterior margins nearly equal in shape and height; the posterior is a trifle higher, but both are broadly and evenly rounded and thin at the edge. The ventral margin is also thin at the edge and presents a long, arcuate, keel-like outline. The borders are thin for about one-fourth inch from the edge, and above the pallial line the shell thickens abruptly. There is a slight anterior umbonal ridge which is directed almost vertically downward, but swings anteriorly near the middle portion of the shell and fades out near the anterior muscle scar. The area between the ridge and the scar is depressed.

The shell is only slightly longer than high. The greatest height is about the center of the shell and at the beaks. The greatest thickness is slightly above the middle of the shell beneath the beaks. In the umbonal view the shape of the shell is like a very convex lens with a narrow, sharp rim at either side.

The pallial line is distinct, arcuate, approximately parallel to the ventral margin. The short vertical ridges and depressions which are found mostly above the pallial line stand out clearly. The pallial sinus is deep, wide and directed upward at a steep angle. The anterior end is narrow, rounded at the point. The sides are wavy and converging. The posterior muscle scar is large, oval, raised on the anterior side, covered with concentric rings. Anterior muscle scar elongate, elevated greatly on the posterior side, depressed on the anterior side. At the cardinal margin it turns and proceeds along the margin for a short distance and becomes very narrow—attenuating to about 1 mm. It expands below to nearly half an inch in width. It is covered with vertical, gently curved striae. The central portion of the scar is concave. None of the specimens at hand shows ornamentation.

This species differs from *M. texana* (Conrad) in being shorter, higher, and more ventricose. The cardinal margin rises at a steeper angle and is more arched. There is a more pronounced anterior umbonal ridge present, and the posterior and anterior ends are more nearly equal in size and shape. The posterior muscle scar is more distinct and the anterior muscle scar is depressed in the center while it is very slightly convex in *M. texana*.

Dimensions: height 55 mm., length 63 mm., width 34 mm.

Occurrence.—One mile east of Bandera, Tex; Cranes Mill at the big spring on Guadalupe River, Comal County, Tex.

Type locality.—One mile east of Bandera, Texas.

Family SAXICAVIDAE Gray
Genus PANOPEA Menard
PANOPEA SELLARDSI Whitney, n. sp.
Plate 15, figures 7, 8

Casts small, narrow, long, and attenuated at the ends; equivalve, inequilateral, quite thick below the beaks, usually thin at the ends. Beaks low, rounded, close together, and very slightly subcentral. A low ridge extends from the beaks to the pallial margin on the anterior side. Hinge unknown. Umbonal margin long and gently sloping on either side of the beaks. Anterior end is usually closed, while the posterior end is usually gaping, attenuated, and quite flaring. Ventral margin gently curved. Sides lined with irregular, concentric ridges. Pallial line indistinct, pallial sinus shallow and narrow. Anterior muscle scar small, oblique, and oval shaped.

Dimensions: height 28 mm., length 55 mm., width 23 mm.

Occurrence.—Middle Glen Rose 1 mile east of Bandera, Tex., and on Comfort-Boerne road, 10 miles from Boerne, Tex.

Type locality.—One mile east of Bandera, Texas, *Salenia texana* horizon.

Family ANATINIDAE Dall
Genus ANATINA Lamarck
ANATINA HANSENI Whitney, n. sp.
Plate 15, figures 3, 4

Cast large, quite high and thin, equivalve, inequilateral. Beaks practically central, small, angular, close together. Umbonal margin long and narrow, high; more steeply sloping and narrower on the anterior side than on the posterior side. Anterior margin wide, broadly curved. Pallial margin curving at ends, almost straight in the middle for about $1\frac{1}{4}$ inches. Posterior margin wide and gaping, slightly flaring but the shape indistinct on the specimens at hand because of erosion. Hinge unknown. Along the posterior umbonal margin there is a narrow groove on each valve which passes down from the beaks to the posterior side. Originating at the same point as the umbonal grooves there is a deep, narrow, short groove which extends obliquely downward from the umbonal region across the posterior end of the shell for the distance of about five-eighths of an inch. There does not seem to be any depression on the anterior side of the casts. Sides lined with irregular, concentric ribs, coarse on some specimens and fine on others. The pallial line does not show, but a faint suggestion of the pallial sinus can be found on one specimen. It appears to be very shallow and quite narrow.

Dimensions: height 38 mm., length 65 mm., width 21 mm.

Occurrence.—*Salenia texana* horizon on the Hansen ranch near Bandera. Also found 1 mile east of Bandera, Tex. A smaller specimen was found on Bull Creek near Austin, very close to the top of the formation.

Type locality.—*Salenia texana* zone, 9 miles west of Bandera, Texas.

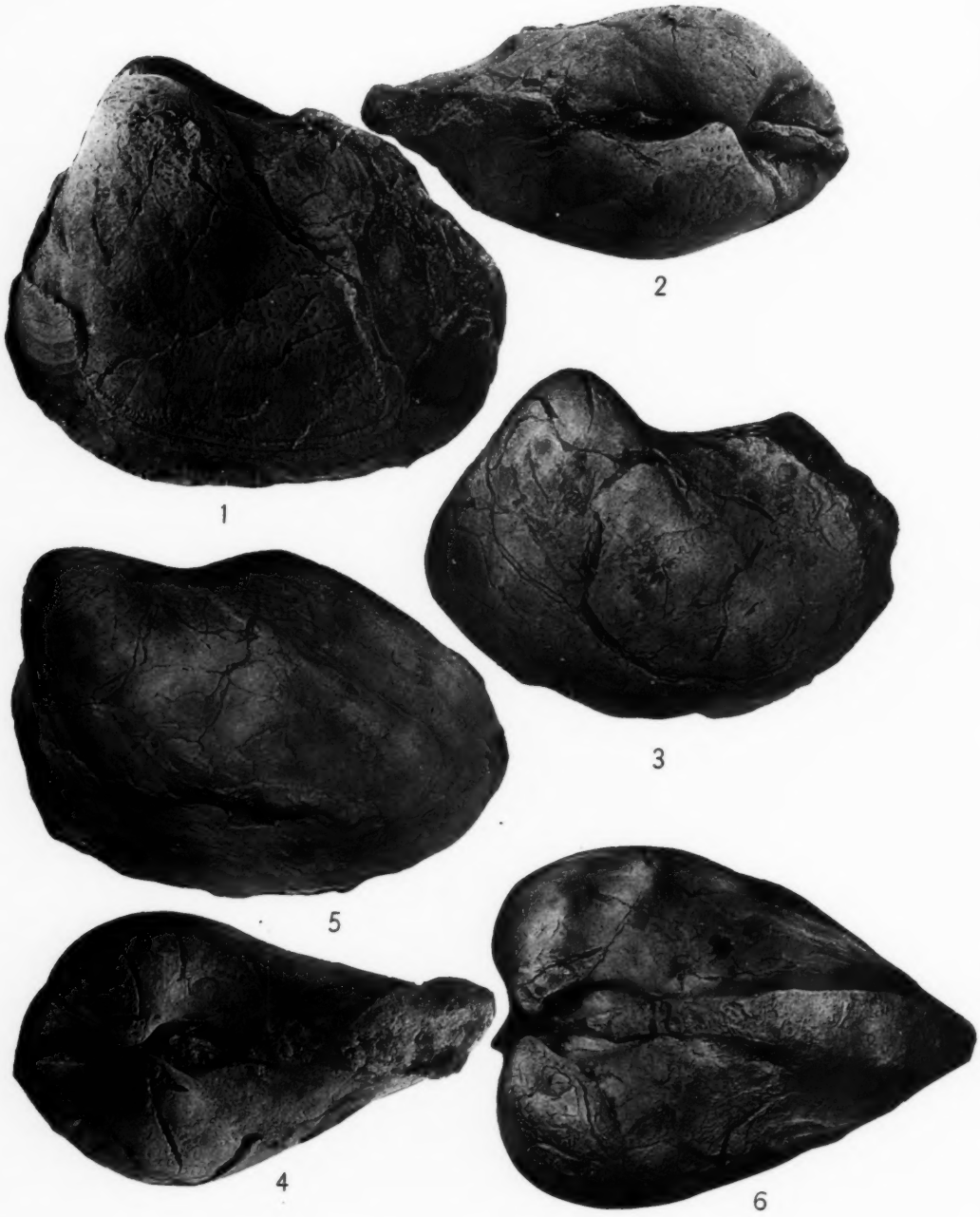
ANATINA SIMONDSI Whitney, n. sp.
Plate 15, figures 5, 6

Cast long, narrow, generally quite thin, but sometimes thickened due to compression, equivalve, inequilateral. Beaks almost central, low, not prominent, angular particularly on the posterior side, close together. Umbonal margin very long; slightly curved and sharp anteriorly; long, straight and gently sloping posteriorly. Anterior margin narrow, sharply rounded. Ventral margin long, changing its curvature at the anterior depression, where it swings in a long, sweeping curve upward toward the very narrow, attenuated posterior margin. The posterior appears to be very slightly gaping and only slightly flared. The umbonal grooves are deep, narrow, and long. The grooves which extend obliquely downward poste-

EXPLANATION OF PLATE 15

FIGS. *1, 2*—*Anatina beckleyi* Whitney, n. sp., lateral and dorsal views, ×1. (p. 71)
3, 4—*Anatina hanseni* Whitney, n. sp., lateral and dorsal views, ×1. (p. 70)
5, 6—*Anatina simondsi* Whitney, n. sp., lateral and dorsal views, ×1. (p. 70)
7, 8—*Panopea sellardsi* Whitney, n. sp., lateral and dorsal views, ×1. (p. 70)

Whitney, Glen Rose fauna



Whitney, Glen Rose fauna

riorly from the beaks are deep and narrow for a short distance, but suddenly flatten out into a low depression which can be traced to the ventral margin on some specimens. The anterior depressions originate in the middle of the umbones and extend obliquely to the ventral margin, increasingly slightly in depth as they approach the margin. Hinge unknown. Sides lined by more or less regular concentric ribs which increase in size toward the ventral margin.

This species differs from *A. hanseni* chiefly in the fact that it is not so high and it has more attenuated ends. The ventral margin is also more sloping in *A. simondsi* and the anterior depression is noticeable, whereas it is not apparent in *A. hanseni*.

Dimensions: height 29 mm., length 66 mm., width 15 mm.

Occurrence.—Middle Glen Rose 1 mile east of Bandera, Tex.

Type locality.—Six miles SE of Bandera, Texas, *Salenia texana* horizon.

ANATINA BECKLEYI Whitney, n. sp.
Plate 15, figures 1, 2

Cast elongate, suboval, equivalve, inequilateral, compressed, high. Beaks central, small, rounded, Posterior cardinal margin sloping, concave, gaping. Anterior cardinal margin straight from the top of the beaks for about half an inch, curved gently from that point to the broadly rounded, high carinate anterior margin. The ventral margin is arcuate, lower on the anterior side than on the posterior side, carinate, and rises from the middle to the narrowed, gaping posterior. The anterior side is higher than the posterior side. The posterior groove is deep and narrow, about 19 mm. long. It extends obliquely downward onto the flank and suddenly disappears. Only a very faint suggestion of a depression exists in the middle of the shell below the beaks. The umbonal ridge is narrowly rounded and short. The greatest width is below and slightly posterior to the beaks. The greatest height is at the beaks. The sides are lined with coarse, irregular, concentric lines.

Anatina beckleyi differs from *A. hanseni* in being shorter, higher and straighter on the anterior cardinal margin, lower on the anterior ventral margin and narrower posteriorly. Also the posterior cardinal margin is more sloping and the posterior is less gaping and not flared.

Dimensions: height 38 mm., length 55 mm., width 13 mm.

Type locality.—About 275 feet above the base of the Glen Rose on the Blanco-New Braunfels road about 10 miles from Blanco, Tex. Collected by Mr. W. B. Beckley.

Family NERINEIDAE
Genus NERINEA Defrance
NERINEA ROEMERI Whitney, n. sp.
Plate 14, figures 1, 2

Nerinea sp. indt. ROEMER, Texas, p. 412. Bonn, 1849.

Nerinea sp. indt. Roemer, Die Kreidebildungen von Texas, p. 41, pl. 4, fig. 8. Bonn, 1852.

Original description (Roemer's *Nerinea* sp., 1852)

Shell elongate, turreted, the whorls of the cast consist of two parts separated in the middle by a groove in which two almost equally sloping surfaces come together. This species, of which there is, at hand, only a single, somewhat compressed specimen preserved as a cast, is related through the concave almost equally divided whorls of the cast to *Nerinea gosae* by A. Roemer (Nordd. Oolith. Geb. Tab. X1, Fig. 27) of the upper Jurassic, yet it seems in the Texas species the division of the whorl by the middle groove is not so complete as the former species. Under the species of the Cretaceous come the casts of *Nerinea Espaillaciana* d'Orbigny, (L. C., pl. 164, Fig. 2) that is very near to the cast, at hand, from Texas. But the whorls divided by the groove seem broader than in the Texas species.

Locality. With the former species on the upper course of the Pedernales.

Dimensions: width 35 mm., spiral angle 5°, sutural angle 15°.

EXPLANATION OF PLATE 16

FIGS. *1, 2—Liopistha* (*Psilomya*) *banderaensis* Whitney, n. sp., lateral and dorsal views, about ×2/3. (p. 67)

3, 4—Liopistha (*Psilomya*) *fletcheri* Whitney, n. sp., lateral and dorsal views, about ×2/3. (p. 68)

5, 6—Liopistha (*Psilomya*) *walkeri* Whitney, n. sp., lateral and dorsal views, about ×2/3. (p. 68)

Affinities.—The shell is very elongate and slender. The longest specimen, at hand, of which about one-half is preserved, measures over 20 cm. It is closely related to *Nerinea espaillaciana* d'Orb. except in the respect which Roemer pointed out, namely, that in *N. espaillaciana* the whorls are broader in proportion to their length than in *N. roemeri*. The pattern of the plaits in these species is very similar, there being one plait on the outer lip and two on the inner lip. D'Orbigny points out that the outer plait in *N. espaillaciana* is much more prominent than the others and is sharply truncated. This holds true for *N. roemeri*, but in addition to the three plaits there seems to be a faint notch about midway between the posterior and anterior plaits on the inner lip. Although the pattern of the plaits is, in general, similar in the two species, there is a difference in the proportion of the lobes. In *N. espaillaciana* the posterior lobe is larger than the anterior lobe, whereas in *N. roemeri* this condition is reversed. Both species are tightly coiled about small columellas. The spiral and sutural angles, and the angles of the whorls are practically the same for the two species.

Occurrence.—Near Wimberly on Dripping Springs road. Bandera, Smithson Valley, and Fischer Store, Texas.

Type locality.—About 2½ miles south of Lone Man Mt., *Salenia texana* horizon.

Family STROMBIDAE d'Orbigny
Genus STROMBUS Linn.
STROMBUS BECKLEYI Whitney, n. sp.
Plate 13, figures 6, 7

Cast small, very elongate, narrow, turriculate. The spire is high, composed of about five whorls which increase regularly in size. The last whorl is somewhat larger than the others. The sides are very gently rounded. The whorls are separated by a deep, fairly wide, canaliculate, oblique suture. The aperture is quite wide, slightly flared but not greatly expanded. The lip is somewhat expanded upward. The anterior canal is short and only a very faint depression in the lip indicates the position of the sinus. The posterior end of the aperture is acuminate, while the anterior end is broad, flattened and obliquely truncate. Spiral angle about 35°. Slight indications of varices can be seen on the sides. They are nearly 180° apart.

Strombus beckleyi was found by Mr. W. B. Beckley. It resembles *S. fischeri* Choffat in general appearance, but the body whorl is not so large as in *S. fischeri*. Choffat wrote that the body whorl of his species occupies about half the length of the shell. The body whorl in the specimens at hand occupies a little more than one-third the length of the shell.

Dimensions: length 50 mm., width 20 mm.

Occurrence.—*Salenia texana* horizon of the Glen Rose formation about 10 miles from Blanco City on the Blanco-New Braunfels road and in most of the outcrops of this horizon.

Type locality.—New Braunfels-Blanco road about 10 miles from Blanco near county line.

Family PLEUROTOMARIIDAE d'Orbigny
Genus PLEUROTOMARIA Defrance
PLEUROTOMARIA GLENROSENSIS Whitney, n. sp.
Plate 13, figures 4, 5

Cast small, depressed, orbicular. Spire low, consisting of four whorls which increase regularly in size. The last whorl is fairly large. The whorls develop a rather marked keel. They are flattened on top, and the side is short, steeply sloping and truncated at the keel. About six revolving lines decorate the upper side. A few traces of revolving lines can be seen on the flattened anterior side also. The shoulders are fairly wide. The suture is distinct and narrow. The umbilicus is wide and shallow. Angle of spire 121°.

Dimensions: length 7 mm., width 14 mm.

Occurrence.—Fischer Store, Tex., New Braunfels-Blanco road.

Type locality.—New Braunfels-Blanco road about 10 miles east of Blanco, *Salenia texana* horizon.

Family NATICIDAE Forbes
Genus TYLOSTOMA Sharpe
TYLOSTOMA TRAVISENSIS Whitney, n. sp.
Plate 13, figures 1–3

Cast medium size, subovate. Spire quite high, consisting of six gently convex whorls which increase rapidly in size. The mouth is semilunular in shape. It is rather sharply

pointed at the posterior end, gently curved at first, but the curvature becomes quite considerable at the anterior end. Here also the opening is much wider and flares over a constriction that is slightly posterior to the margin. The lip extends upward and swings outward at the posterior end. The varices are faint. The cast is smooth and no portion of the original shell has been preserved in any of the specimens. Spiral angle about 57°.

Tylostoma travisensis bears considerable resemblance to *T. chihuahuense* Böse, but the body whorl of the latter species is much broader in proportion to the height than in *T. travisensis*.

Dimensions: length about 76 mm., width at outer lip 38 mm.

Occurrence.—Abundant in the Glen Rose; found in Bandera, Comal, Travis, Kendal, Blanco and Hays Counties. Some specific points at which it is found are Sandy Creek, Travis County; Hansen ranch, Bandera County; Kuhn Hill on Cranes Mill-Fischer Store road, Comal County.

Type locality.—*Salenia texana* horizon, Hansen ranch north west of Bandera, Texas.

BIBLIOGRAPHY

ADKINS, W. S., 1928, Handbook of Cretaceous fossils: University Texas Bull. 2838.

BÖSE, EMILIO, 1910, Monographía geólogica y paleontologica del Cerro de Muleros: Ist. Geol. Mexico, Bol. 25.

BOYLE, C. B., 1893, A catalogue and bibliography of North American Mesozoic Invertebrata: U. S. Geol. Survey Bull. 102.

CONRAD, T. A., 1857, Report of the U. S. and Mexico boundary survey, vol. 1.

CRAGIN, F. W., 1893, Invertebrate paleontology of the Texas Cretaceous: Texas Geol. Survey, Fourth Ann. Rept.

D'ORBIGNY, ALCIDE, 1843–1847, Description des Mollusques et Rayonnes Fossiles Terraines Crétacés. Paléontology française.

FISCHER, PAUL, 1887, Manual de Conchyliologie et de Paléontologie conchyliologique. Paris.

HAMLIN, C. E., 1884, Results of an examination of Syrian molluscan fossils chiefly from the range of Mount Lebanon: Mem. Mus. Comparative Zoology Harvard College, vol. 10, no. 3.

HILL, R. T., 1901, The geology and geography of the Black and Grand Prairies of Texas, U. S. Geol. Survey, 21st Annual Report, pt. 7.

PICTET, F. F., 1853–1857, Traité de Paléontologie au Histoire Naturelle des Animaux Fossiles.

PECTET, F. J. and CAMPICHE, G., 1858–1873, Description des fossiles du terrain Crétacé des environs de Saint Croix: Mater. pour la Paleont. Suisse, Geneve et Bale, vol. 2.

ROEMER, FERD., 1852, Die Kreidebildungen von Texas und ihre organischen Einschlüsse: Bonn.

SHARPE, D., 1849, On *Tylostoma*, a proposed genus of gasteropodous mollusks: Geol. Soc. London Quart. Jour., vol. 5.

SHUMARD, B. F., 1862, Descriptions of new Cretaceous fossils from Texas: Proc. Boston Soc. Nat. Hist., vol. 8.

——, 1853, Paleontology, natural history of the Red River of Louisiana, reprinted from the report of Captain R. M. Marcy, Fifth Infantry, U.S.A., Washington.

SOWERBY, JAMES, 1825, The genera of Recent and fossil shells. London.

STOLICZKA, FERD. 1868, Cretaceous fauna of southern India: Mem. Geol. Survey India, vol. 2, The Gastropoda.

TWENHOFEL, W. H., 1924, Geology and invertebrate paleontology of the Comanchean and Dakota formations of Kansas: Kansas State Geol. Survey Bull. 9.

WHITE, C. A., 1879–1880, Description of new Cretaceous invertebrate fossils from Kansas and Texas: Proc. U. S. Nat. Museum, vol. 2, pt. 2, 1879, Washington, 1880; Smithsonian Misc. Coll., vol. 19.

WHITNEY, F. L., 1929, Bibliography and index of Mesozoic invertebrata: Bull. Amer. Paleontology, vol. 12, no. 48.

ZEKELE, FREDERICH, 1852, Gastropoden der Gosaugebilde, Wien.

ZITTEL, K. A. VON, 1863–1865, Bivalven der Gosaugebilde in den nordöstlichen Alpen.

——, 1896, Textbook of Paleontology.

——, 1924, Grundzüge Der Paleontologie. Munich and Berlin, R. Oldenbourg.

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OSTRACODES FROM THE UPPER PENNSYLVANIAN OF MISSOURI. PART I: THE FAMILY BAIRDIIDAE

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ABSTRACT—Upper Pennsylvanian strata of Missouri, ranging from the top of the Pleasanton group to the base of the Kanwaka formation, contain large numbers and a wide variety of ostracodes. The present study is focused on the Family Bairdiidae, which is represented by the following genera: *Acratia*, *Bairdia*, *Bairdiacypris*, *Bairdianella*, *Bythocypris*, *Fabalicypris*, *Macrocypris*, *Microcheilinella*, and doubtfully *Waylandella*. Nine species and one genus are demonstrated to have value as guide fossils in the Upper Pennsylvanian of Missouri. Six of the species are shown to have probable value in regional or inter-basin correlations. Altogether, the collections contain 46 species which are classified within the Bairdiidae. Where clarity of specific boundaries requires, comparisons are made with closely related species. The genus *Bairdia*, which contains more specimens than any other bairdiid genus in the collections, is represented by 25 species.

INTRODUCTION

ALTHOUGH a large number of reports have been written on Pennsylvanian ostracodes, there has been no general agreement on their value in stratigraphic correlations. Previous investigations have been widely separated areally, and with a few exceptions, published reports have dealt with collections from rather limited stratigraphic successions and from a small number of localities. One purpose of the present report is to bridge in part the areal gap between the Illinois ostracode studies of Cooper (1946) and the northern Mid-Continent investigations of Kellett (Mrs. E. H. Nadeau) (1929; 1933; 1934; 1935; 1936) and Johnson (1936).

The strata covered in the present investigation are in the interval between the top of the Pleasanton group and the lower part of the Shawnee group. Most of Kellett's published investigations in Kansas were concentrated on strata from the Stanton formation (Lansing group) to the Lower Permian, inclusive. However, she has also published detailed information on ostracode occurrences in strata as low as the Marmaton group. Johnson's studies embrace most of the Missourian series of Nebraska, including the Kansas City and Lansing groups. In Illinois, Cooper reported on the ostracodes from the entire Pennsylvanian section. Although the stratigraphic successions investigated in Kansas, Nebraska, Illinois, and Missouri are not mutually inclusive, some degree of correlation of the faunas is possible from present knowledge. A comprehensive report by Bradfield (1935) and several papers by Harlton (1927; 1928; 1929; 1929a; 1933) and by Coryell and associates add significantly to knowledge of Pennsylvanian ostracodes in Oklahoma and Texas.

In the process of identification and description of bairdiid species, all the available Pennsylvanian bairdiid types of Cooper, Kellett, Harlton, and Delo (1930; 1931) were examined. Also, a few types deposited by Warthin (1930) and by Roth and Skinner (1930) were studied. Further examination and comparison of type specimens should alleviate many of the problems of taxonomy, and permit a closer evaluation of ostracodes as guide fossils.

The stratigraphic summary is based largely on the work of Moore (1936; 1948) and Greene and Searight (1949). However, the present author is responsible for local identification of all strata in which the faunas being studied were collected. Several Missouri stratigraphic reports were of assistance in determining local correlations of beds. For this purpose, reference was made to stratigraphic reports by Broadhead (1866; 1873; 1895), Hinds (1912), Hinds and Greene (1915; 1917), McCourt, Albertson, and Bennett (1917), Greene (1933), and McQueen and Greene (1938).

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The author is indebted to the late Dr. E. B. Branson, of the University of Missouri, for suggesting an investigation of the Pennsylvanian ostracodes of Missouri. Dr. Branson gave advice on general procedure during the early stages of project. Dr. Raymond E. Peck, of the University of Missouri, served as advisor during the later stages of the work, which involved studies of the entire ostracode fauna from the top of the Pleasanton shale to the base of the Kanwaka shale. The Missouri Geological Survey contributed funds for field expenses during the summer of 1947. Facilities of the Survey were made available by Dr. Edward L. Clark, State Geologist, and Dr. Walter V. Searight, Principal Geologist. Mrs. Betty Kellett Nadeau examined the ostracode collections, and was particularly helpful with suggestions on differentiation of certain species. In addition, she placed her Pennsylvanian and Permian ostracode specimens at the author's disposal. The Illinois Geological Survey granted access to Dr. C. L. Cooper's Pennsylvanian ostracode types. Dr. G. Arthur Cooper made available the types deposited at the U. S. National Museum. Dr. H. W. Scott, of the University of Illinois, provided laboratory and library facilities at that institution during part of the summer of 1948. Dr. A. G. Unklesbay, of the University of Missouri, read the descriptions and made helpful comments. Advice on photography and preparation of plates was provided by Dr. M. G. Mehl, of the University of Missouri. Much of the development of negatives and prints was done by Mr. H. W. Miller. Mr. Joseph Sparacio assisted in the preparation of samples for about a week. Finally, the author's wife, Mrs. Frances Cordell, did most of the work of sample preparation, and was a continual source of encouragement throughout the investigation.

STRATIGRAPHY

The stratigraphic groups from which the ostracode collections were taken are the following, in upward order: Pleasanton (only the uppermost few inches), Kansas City, Lansing, Pedee, Douglas, and Shawnee (only the basal portion). The first four of these groups are placed in the Missourian series, whereas the latter two are parts of the Virgilian series. The Missourian and Virgilian are separated by an important unconformity which extends through much of the northern Mid-Continent. This break occurs at the base of the Douglas group, where detrital sediments of the lower part of the Douglas bevel beds of the Iatan, Weston, and Stanton formations.

The groups are distinguished from one another mostly on the basis of the principal rock type or types, whether detrital, calcareous, or a substantial combination of both. Formational contacts are drawn between successions of different dominant rock types or between sedimentary cycles. These cycles were discussed in detail by Moore (1936). The most common rock types of the Mid-Continent are sandstone, sandy shale, clay, coal, black shale, and limestone. A Pennsylvanian limestone is typically one of the following structural types: (1) Regularly bedded and jointed, (2) thinly and irregularly bedded, (3) oolitic, and (4) nodular. Lithologic and structural types recur at more or less regular intervals in the section.

A discussion is given below of the stratigraphic groups from which the collections were taken.

Missourian series

Pleasanton group.—The Pleasanton is composed mostly of shale and sandstone. Definite formational and member status has not yet been assigned to subdivisions of the Pleasanton. The lower contact of the group is unconformable, and in Missouri it is placed at the base of the Hepler sandstone (Greene and Searight, 1949, fig. 1, p. 10). The upper contact is at the base of the Hertha formation. The thickness of the Pleasanton is difficult to determine at many localities, but it is believed to range from 100 to 200 feet in Missouri.

Kansas City group.—The basal formation of the Kansas City, the Hertha, rests conformably on the Pleasanton group. Where the thin basal member of the Hertha, the Critzer limestone, is poorly developed, the exact position of the Pleasanton-Kansas City contact is difficult to determine. The top of the Bonner Springs formation (base of the Plattsburg formation) is the upper

boundary of the Kansas City. This contact is conformable, and it separates older dominantly argillaceous strata from overlying beds which are mainly calcareous. The Kansas City has recently been divided into three subgroups, in upward order, the Bronson, the Linn, and the Zarah (Moore, 1948, pp. 2029–2030, fig. 4; Greene and Searight, 1949, fig. 2, pp. 11–14). The Bronson contains prominent limestones, and in Missouri it ranges in thickness from 55 to 100 feet. The Linn consists mostly of shales, but includes a few thin limestone members. Its thickness in Missouri is from 55 to 80 feet. The Zarah is mainly shale in most parts of northern and northwestern Missouri, and its thickness is from 70 to 150 feet.

Lansing group.—The Lansing consists of interbedded limestone and shale units, the most conspicuous members being the Spring Hill and Stoner limestones. The uppermost beds of the Lansing are not well exposed in most places, as they are not well indurated and are commonly concealed by the shale slope of the overlying Weston formation. The range in thickness of the Lansing in Missouri is from 40 to 75 feet.

Pedee group.—Conformably overlying the Lansing is the Pedee group, which consists of two formations, the Weston shale below and the Iatan limestone above. The Weston is one of the thickest shales in the Mid-Continent Pennsylvanian, and the Iatan has well above the average thickness of Pennsylvanian limestones. The thickness of the Pedee in its outcrop areas in Missouri ranges from 0 to 115 feet.

Virgilian series

Douglas group.—The Douglas unconformably overlies the Pedee group and is overlain conformably by the Shawnee group. The basal contact of the Douglas is uneven, owing to differential channeling and beveling of older beds. The group is primarily clastic, consisting mostly of sandstone and sandy shale. Two thin limestone members occur in the Douglas in most places in northwestern Missouri. The approximate thickness of the Douglas in Missouri is from 125 to 240 feet.

Shawnee group.—Resting on the Douglas is the Shawnee group. Only its basal formation, the Oread, and the basal few inches of the overlying Kanwaka shale are involved in the present investigation. The Oread consists of alternating limestone and shale members. The limestones are more prominent than the shales, and the most conspicuous limestone is the Plattsmouth. In Missouri, the approximate thickness of the Shawnee group as a whole is from 220 to 270 feet, and of the Oread formation, 35 to 60 feet.

DETAILED STRATIGRAPHIC CLASSIFICATION

The present classification of the Pennsylvanian strata of Missouri is the result of the combined contributions of many Mid-Continent geologists, particularly those in Missouri and Kansas. Collation and revision by Moore (1948) of the results of earlier investigations gave rise to the standard inter-state Pennsylvanian classification. The recent revision of the post-Cherokee Pennsylvanian classification of Missouri by Greene and Searight (1949) does not depart widely from the inter-state standard. The part of the Missouri Pennsylvanian involved in the present report is given below, as classified by Greene and Searight.

Top
Pennsylvanian system
  Virgilian series
    Shawnee group
      Kanwaka fm.
      Oread fm.
        Kereford ls. member
        Heumader sh. member
        Plattsmouth ls. member
        Heebner sh. member
        Leavenworth ls. member
        Snyderville sh. member
        Toronto ls. member
    Douglas group
      Lawrence fm.
        Shale member (unnamed)
        Amazonia ls. member
        Shale member (unnamed)
      Stranger fm.
        Haskell ls. member
        Vinland sh. member
        Tonganoxie ss. member
Unconformity
  Missourian series
    Pedee group
      Iatan fm.
      Weston fm.
    Lansing group
      Stanton fm.
        South Bend ls. member
        Rock Lake sh. member
        Stoner ls. member
        Eudora sh. member
        Captain Creek ls. member

Vilas fm.
Plattsburg fm.
Spring Hill ls. member
Hickory Creek sh. member
Merriam ls. member
Kansas City group
Zarah subgroup
Bonner Springs fm.
Wyandotte fm.
Farley ls. member
Island Creek sh. member
Argentine ls. member
Quindaro sh. member
Frisbie ls. member
Lane fm.
Linn subgroup
Iola fm.
Raytown ls. member
Muncie Creek sh. member
Paola ls. member
Chanute fm.
Drum fm.
Cement City ls. member
Cherryvale fm.
Quivira sh. member
Westerville ls. member
Wea sh. member
Block ls. member
Fontana sh. member
Bronson subgroup
Dennis fm.
Winterset ls. member
Stark sh. member
Canville ls. member
Galesburg fm.
Swope fm.
Bethany Falls ls. member
Hushpuckney sh. member
Middle Creek ls. member
Ladore fm.
Hertha fm.
Sniabar ls. member
Mound City sh. member
Critzer ls. member
Pleasanton group

Base

OSTRACODE GUIDE SPECIES

When only part of a stratigraphic system is studied in detail, formulated lists of index fossils may be unreliable. This is particularly true when collections are made from a small area. The present report on the Upper Pennsylvanian deals with most of the Missourian series and the lower part of the Virgilian. However, as this is only a part of the total Pennsylvanian section, a discussion of guide fossils is subject to stratigraphic limitations. The samples were collected entirely within the state of Missouri; hence it is difficult to assess fully the persistence of the guide species in other states.

A further problem, more peculiar to the Pennsylvanian than to other systems, is the recurrence of faunas. Periodic repetition of assemblages in the strata reflects the cyclic nature of sedimentation. In the present case, an ostracode species may appear to have a narrow stratigraphic range within the limits of the investigation, but may also occur in other parts of the Pennsylvanian section. Furthermore, facies faunas are common in the Pennsylvanian, as in most other systems. The lateral lithologic changes in contemporaneous sediments are generally accompanied by changes in faunal makeup.

Nevertheless, significant data of use in identification of groups and formations have been assembled, and upper or lower stratigraphic range boundaries of certain species have been provisionally determined. As stated by Weller (1947), the use of Pennsylvanian invertebrates for correlation purposes requires fine discrimination between very similar forms in different parts of the system, as the unconformities do not have sufficiently great magnitude to show good evolutionary breaks.

Within the family Bairdiidae, stratigraphic restrictions in Missouri are shown by one genus, and by nine species belonging to other genera. The probable lower range limits of the following species have been determined: *Bairdia acuminata* Cooper, *Bairdia crassa* Harlton, *Bairdia menardensis* Harlton, *Bairdia perincerta* Kellett, *Bairdia regularis* Cooper, *Microcheilinella parva* Cordell, *Microcheilinella unispinosa* Cooper, and *Waylandella? unicornuta* Cordell. Upper stratigraphic limits of *Bairdia oklahomaensis* Harlton and of the genus *Fabalicypris* Cooper are fairly definitely established.

Pertinent data are given below on species of the Bairdiidae which have a probable upper or lower range limit within the interval between the top of the Pleasanton group and the base of the Kanwaka shale.

Bairdia acuminata Cooper. Known Missouri range, Lane shale to base of Kanwaka shale; probable lower range limit, Lane shale; number of stratigraphic units represented, 14; number of samples, 18.

Bairdia crassa Harlton. Known Missouri range, Stoner limestone to Iatan limestone; probable lower range limit, Stoner limestone; number of stratigraphic units represented, 2; number of samples, 5.

Bairdia menardensis Harlton. Known Missouri range, Quindaro shale to Snyderville shale; probable lower range limit, Quindaro shale; number

of stratigraphic units represented, 9; number of samples, 15.

Bairdia oklahomaensis Harlton. Known Missouri range, Fort Scott formation to top of Wea shale; probable upper range limit, Wea shale; number of stratigraphic units represented, over 8; number of samples, over 20.

Bairdia perincerta Kellett. Known Missouri range, Muncie Creek shale to Leavenworth limestone; probable lower range limit, Muncie Creek shale; number of stratigraphic units represented, 10; number of samples, 16.

Bairdia regularis Cooper. Known Missouri range, Bonner Springs shale to Weston shale; probable lower range limit, Bonner Springs shale; number of stratigraphic units represented, 4; number of samples, 11.

Fabalicypris Cooper. Known Missouri range, Ardmore limestone to Hushpuckney shale; probable upper range limit, Hushpuckney shale; number of stratigraphic units represented, over 4; number of samples, over 6.

Microcheilinella parva Cordell. Known Missouri range, Argentine limestone to Snyderville shale; probable lower range limit, Argentine limestone; number of stratigraphic units represented, 5; number of samples, 5.

Microcheilinella unispinosa Cooper. Known Missouri range, Muncie Creek shale to Upper Lawrence shale; probable lower range limit, Muncie Creek shale; number of stratigraphic units represented, 10; number of samples, 14.

Waylandella? unicornuta Cordell. Known Missouri range, Muncie Creek shale to Snyderville shale; probable lower range limit, Muncie Creek shale; number of stratigraphic units represented, 6; number of samples, 9.

REGIONAL PERSISTENCE OF GUIDE SPECIES

Most of the ostracodes discussed above have been found in at least one state other than Missouri. These occurrences are considered below from the standpoint of potential value in regional or inter-basin correlations of strata. Unless otherwise indicated, the information on regional correlations of strata is taken from investigations by Moore and coauthors (Moore, et al., 1944; Moore, 1948).

Bairdia acuminata Cooper is known from Illinois and Missouri. In Missouri, the probable lower range limit of the species is in the Lane shale, whereas in Illinois (Cooper, 1946, p. 40), the species was found in the Bogota and Little Vermilion zones, which are correlated by Cooper (1946, fig. 2) with the lower Virgilian of the Mid-Continent. Moore, et al. (1944) placed these zones somewhat lower in the section. Cooper (1946, p. 52) described specimens identified as *B. verwiebei* Kellett, from the Shumway zone of Illinois, which according to Moore, et al. (1944) is equivalent to the Stanton, a formation within the known Missouri range. Apparently, these specimens are conspecific with *B. acuminata* rather than *B. verwiebei*. With the occurrences as outlined above, chances are good that *B. acuminata* has about the same stratigraphic range in Illinois as in Missouri.

Bairdia crassa Harlton is present in at least four states, namely, Texas, Kansas, Missouri, and Indiana. The reported occurrence in Texas (Harlton, 1929, p. 158) is in the Canyon series, which is equivalent to the Missourian series. The doubtful identification of the species by Kellett (1934, p. 129) is from the Stanton and Iatan formations of Kansas, the same stratigraphic range as in Missouri. *B. bradfieldi* Payne (1937, p. 283), from the Hayden Branch formation of Indiana, is thought to be conspecific with *B. crassa*. The Hayden Branch is within the Conemaugh, and is possibly about the same age as the Stanton and Iatan. *B. crassa* was also identified in Oklahoma from the Nowata shale (Coryell and Osorio, 1932, p. 33), a unit much older than the occurrences elsewhere. The present author has been unable to see the specimens from the Nowata, and no description or figures are given by the authors. It seems probable that *B. crassa* is confined to a relatively narrow and comparable part of the section in its different occurrences.

Bairdia menardensis Harlton has been reported from Texas, Oklahoma, Missouri, and Illinois. The specimens from the Ardmore Basin of Oklahoma, which Bradfield (1935, p. 85, pl. 6, figs. 4, 5, 9) doubtfully referred to *B. menardensis* are believed to belong to another species. Cooper's specimens from Illinois (1946, p. 47, pl. 2, figs. 32–35) are also thought to be erroneously identified. Harlton (1929, p. 158) originally described *B. menardensis* from the Canyon series of Texas, which is correlated exactly with the Missourian series. Delo (1930, p. 164) found the species in the Texas subsurface, but the stratigraphic horizons are uncertain. Coryell and Osorio (1932, p. 33) listed the species from the Nowata shale, a formation lower than the Missourian series. No figures or description were given, and their specimens were not examined during the present investigation. To summarize,

except for the Nowata occurrence, *B. menardensis* has not been found below the Missourian series. More detailed investigations might show that both the lower and upper range limits can be established within narrow and comparable limits in different areas of the Mid-Continent.

Bairdia oklahomaensis Harlton has been found in Texas, Oklahoma, Missouri, and Illinois. Its seeming absence in Kansas is attributed to the fact that the ostracode content of Kansas beds within its stratigraphic range has not been published. The following reported occurrences should be disregarded, namely, the East Mountain shale of Texas, the Wayland shale of Texas, the Wetumka to Holdenville formations of Oklahoma, and the Lane and Plattsburg formations of Nebraska. In reports on these formations, other species of the genus have been erroneously identified as *B. oklahomaensis*. Harlton (1927, p. 209; 1929, p. 156) reported the species from the Canyon series of Texas and the Glenn group of Oklahoma. As previously stated, the Canyon is equivalent to the Missourian series of the northern Mid-Continent, and the Glenn is correlated with beds below the Missourian. Bradfield (1935, p. 85) in his work in Oklahoma found the species in the Hoxbar group, most of which is correlated with the Missourian series. Knight's species, *Bairdia auricula* (1928, p. 319), which has been placed in the synonymy of *B. oklahomaensis*, occurs in the "Upper Fort Scott" (probably Pawnee) limestone of Missouri (Marmaton group). *B. oklahomaensis* is also listed from the Nowata shale (Coryell and Osorio, 1932, p. 33) of Oklahoma, which is upper Desmoinesian in age. Cooper's specimens of *B. oklahomaensis* (1946, p. 48) from Illinois are from the Fulda to Macoupin zones, inclusive. In Cooper's report (1946, fig. 2), the Fulda is correlated with the upper part of the Morrowian series of the Mid-Continent. This is the oldest occurrence of the species thus far reported. The Macoupin is correlated with the Westerville limestone of Missouri. Accordingly, the upper limits of *B. oklahomaensis* in Missouri and Illinois are about the same, near the base of the Westerville and in the Macoupin, respectively. If the Canyon and Hoxbar specimens are from the lower part in each case, the upper range limit of the species is possibly the same throughout the areal range of the species.

Bairdia perincerta Kellett is known only from Kansas and Missouri. The lower range limit in Missouri is in the Muncie Creek shale, and in Kansas (Kellett, 1934, p. 132) the species is reported only from the Waubansee group, at and near the top of the Pennsylvanian. When ostracodes of the Missourian series in Kansas are studied more intensively, the lower range will possibly prove to be the same as in Missouri.

Bairdia regularis Cooper (1946, p. 50) was reported from the Exline zone of Illinois, which consists of beds much older than the occurrence in Missouri. Hence, the species is of doubtful value for regional correlations.

Species of *Fabalicypris* give promise of usefulness in the Atokan, Desmoinesian, and the lower part of the Missourian series. Cooper (1946) described eight species of the genus from Illinois. None of these ranges as high as the Missourian series. The other main occurrences of the genus are in the Missouri collections. *Fabalicypris* was found in six samples from the top of the Pleasanton to the base of the Hushpuckney member of the Swope formation. *Bairdia warthini* Bradfield (1935, p. 83, pl. 5, figs. 11a, b), from Oklahoma strata older than the Hushpuckney, is apparently a species of *Fabalicypris*, as pointed out by Cooper (1946, p. 60). Cooper also stated that *Bairdia acetalata* Coryell and Billings, from the Wayland shale, is a species of *Fabalicypris*. The types have not been examined, but the present author believes that *B. acetalata* may be synonymous with *Bairdia hoxbarensis* Harlton. Further investigation will possibly show that *Fabalicypris* does not occur in beds higher than the Hushpuckney shale and its equivalents. Certainly, the Hushpuckney is rather definitely the upper range limit in Missouri.

Microcheilinella unispinosa Cooper has previously been reported only by Cooper (1946, p. 63), who found the species in the Little Vermilion zone of the Illinois Pennsylvanian. The age of the Little Vermilion is lower Virgilian, according to Cooper (1946, fig. 2), although Moore, et al. (1944) had correlated the formation doubtfully with the Wyandotte formation, in the Missourian series. *M. unispinosa* is present in Missouri in beds from the Muncie Creek member of

the Iola formation (somewhat lower than the Wyandotte) upward to the upper shale of the Lawrence formation. Further search will possibly show comparable ranges for the species in Missouri and Illinois. More collecting in other states might reveal a more extensive areal range than indicated by present knowledge.

SYSTEMATIC DESCRIPTIONS

Family BAIRDIIDAE Sars, 1887

Genus ACRATIA Delo, 1930

ACRATIA INORNATA Cordell, n. sp.

Plate 20, figures 66–68

Carapace small to medium in size, elongate, thin. Shape in lateral view subrhomboidal, greatest length ventral, greatest height well anterior; dorsal margin unevenly convex, merging with a long posterodorsal slope, which is convex except near the base, where it becomes gently concave; anterodorsal slope absent; ventral margin straight; anterior margin consisting of two parts, the lower part long, gently convex, meeting ventral margin abruptly; the upper part sharply rounded, beak-like, terminating only slightly lower than uppermost extent of dorsal margin; posterior beak narrow, attenuated, terminating nearly as low as ventral margin. In dorsal view carapace subfusiform, sides unevenly convex, ends extremely thin and attenuated, the poste-

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EXPLANATION OF PLATE 17

All figures ×28

FIGS. *1–2*—*Bairdia altifrons* Knight, long form, lateral and dorsal views, hypotype 0-1110-1; Bonner Springs formation, locality 174. (p. 82)

3–4—*Bairdia altifrons* Knight, short form, lateral and dorsal views, hypotype 0-1110-2; Bonner Springs formation, locality 174. (p 82)

5–6—*Bairdia seminalis* Knight, broad form, lateral and dorsal views, hypotype 0-1117-3; Hushpuckney shale, locality 165. (p. 91)

7–8—*Bairdia seminalis* Knight, narrow form, dorsal and alteral views, hypotype 0-1117-4; Bethany Falls limestone, locality 205. (p. 91)

9–10—*Bairdia kansasensis* Kellett, long form, lateral and dorsal views, homoeotype 0-1112-4; Raytown limestone, locality 196. (p. 86)

11–12—*Bairdia kansasensis* Kellett, short form, lateral and dorsal views, homoeotype 0-1112-3; Bonner Springs formation, locality 106. (p. 86)

13–14—*Bairdia acuminata* Cooper, lateral and dorsal views, homoeotype 0-1109-4; Bonner Springs formation, locality 194. (p. 82)

15–16—*Bairdia acuminata* Cooper, dorsal and lateral views, homoeotype 0-1109-5; Vilas formation, locality 235. (p. 82)

17–18—*Bairdia coryelli* Roth and Skinner, dorsal and lateral views, homoeotype 0-1110-5; Hickory Creek shale, locality 106. (p. 84)

19–20—*Bairdia coryelli* Roth and Skinner, lateral and dorsal views, homoeotype 0-1111-1; Spring Hill member, locality 172. (p. 84)

21—*Bairdia perincerta* Kellett, lateral view, homoeotype 0-1114-2; Hickory Creek shale, locality 173. (p. 88)

22–23—*Bairdia perincerta* Kellett, lateral and dorsal views, homoeotype 0-1114-3; lower shale of Lawrence formation, locality 191. (p. 88)

24–25—*Bairdia reussiana* Kirkby, dorsal and lateral views, hypotype 0-1115-5; lower shale of Lawrence formation, locality 228. (p. 89)

26—*Bairdia reussiana* Kirkby, lateral view, hypotype 0-1115-4; Vilas formation, locality 235. (p. 89)

27–28—*Bairdia reussiana* Kirkby, dorsal and lateral views, hypotype 0-1128-1: South Bend limestone, locality 236. (p. 89)

29–30—*Bairdia menardensis* Harlton, lateral and dorsal views, adult specimen, homoeotype 0-1113-2; upper shale of Lawrence formation, locality 191. (p. 87)

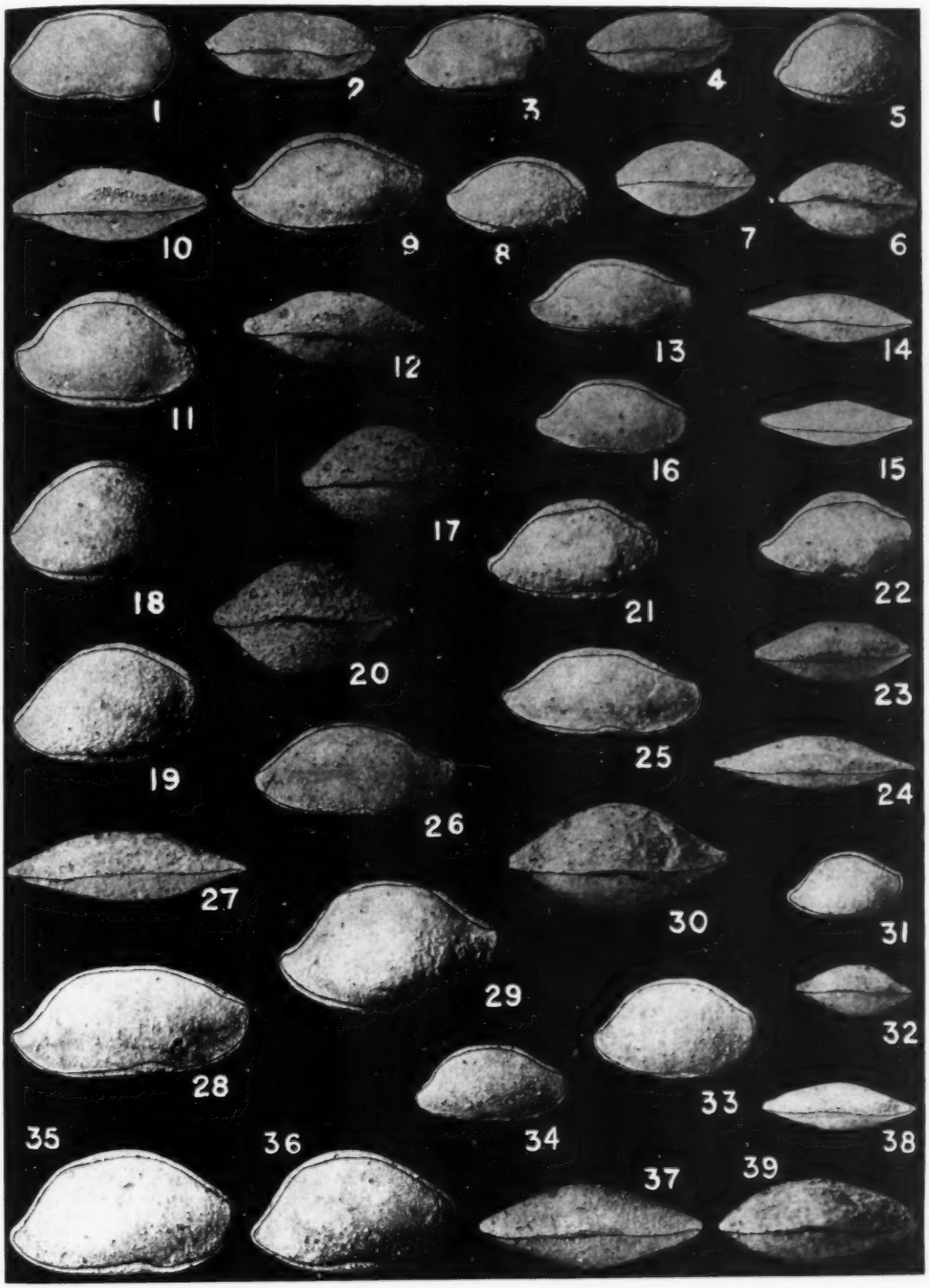
31–32—*Bairdia menardensis* Harlton, lateral and dorsal views, young molt, homoeotype 0-1113-3; lower shale of Lawrence formation, locality 240. (p. 87)

33—*Bairdia menardensis* Harlton, lateral view, medium-sized molt, homoeotype 0-1113-4; lower shale of Lawrence formation, locality 240. (p. 87)

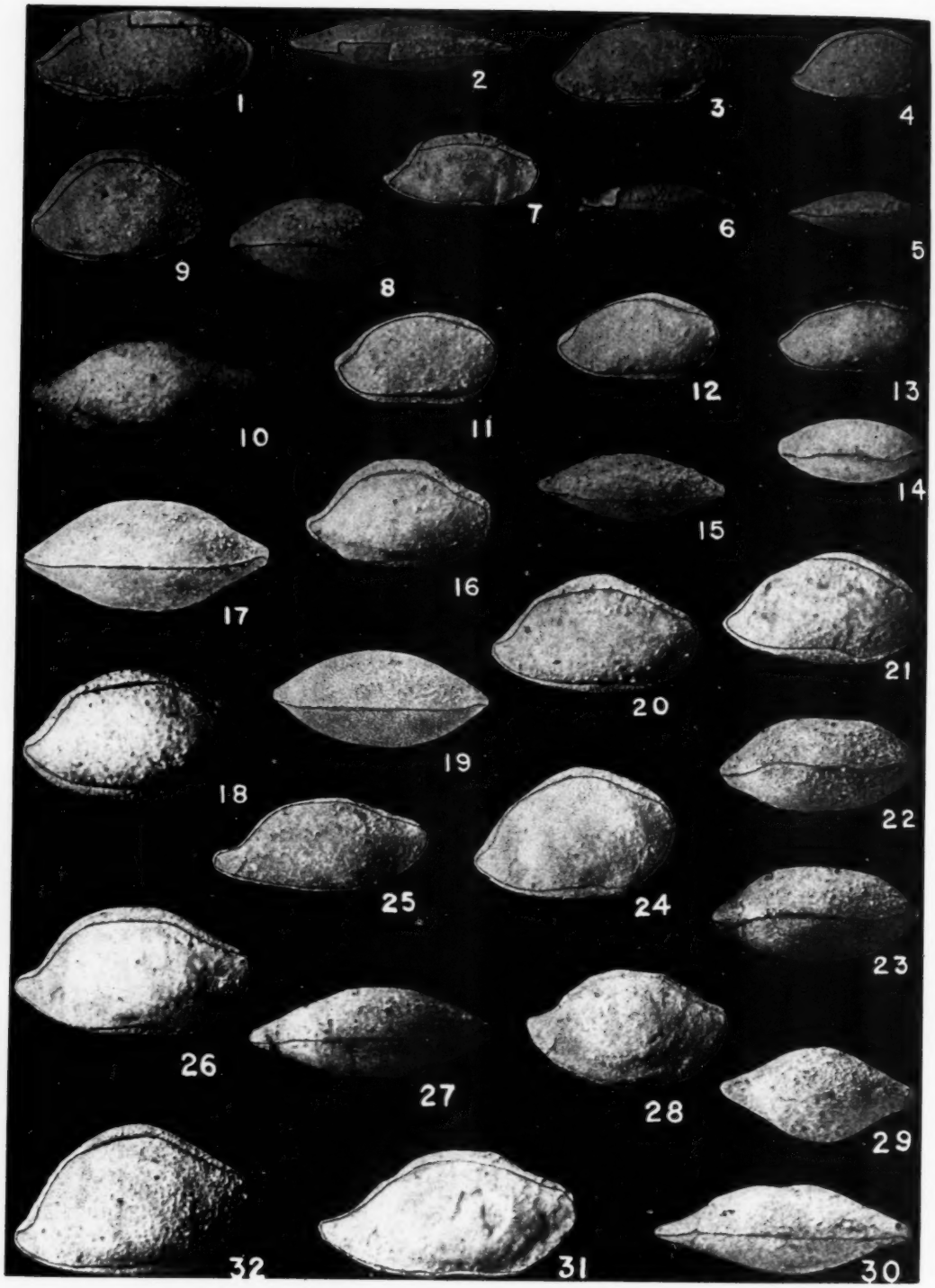
34, 38—*Bairdia regularis* Cooper, lateral and dorsal views, young molt, homoeotype 0-1115-2; Bonner Springs formation, locality 194. (p. 89)

35, 37—*Bairdia regularis* Cooper, lateral and dorsal views, adult specimen, homoeotype 0-1115-3; Bonner Springs formation, locality 194. (p. 89)

36, 39—*Bairdia regularis* Cooper, lateral and dorsal views, adult specimen, homoeotype 0-1115-1; Bonner Springs formation, locality 174. (p. 89)



Cordell, Missouri Pennsylvanian Bairdiidae



Cordell, Missouri Pennsylvanian Bairdiidae

rior end the more so; greatest thickness anterior; valve contact in dorsal view essentially straight. Overlap obscure except along ventral margin, where it is narrow and straight. Surface smooth.

Length, 0.74 mm.; height, 0.34 mm.; thickness, 0.26 mm.

Specimens of the species differ considerably in form ratio and in attenuation of the ends. The high, rounded termination of the anterior end differentiates *A. inornata* from other species of *Acratia* which have a lower, narrower anterior termination. Furthermore, *A. inornata* is much thinner than other species of the genus.

Occurrence.—Dennis formation, Stark member, locality 206, one specimen. Iatan formation, locality 233, four specimens; locality 238, abundant. Lawrence formation, lower shale member, locality 191, one specimen; locality 240, one specimen; upper shale member, locality 191, one specimen.

Holotype.—University of Missouri 0-1109-1, lower shale of Lawrence formation, locality 240.

ACRATIA RECURVATA Cordell, n. sp.
Plate 20, figures 62–65

Carapace medium in size, elongate, tumid. Shape in lateral view subrhomboidal, greatest length ventral, greatest height anterior; dorsal margin moderately and evenly convex, merging imperceptibly with anterodorsal slope, meeting posterodorsal slope smoothly; ventral margin straight; anterior margin sharply sinuous, with a hook which points downward and backward, terminating below midheight; posterior beak low,

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EXPLANATION OF PLATE 18

All figures ×28

FIGS. *1–2—Bairdia reussiana* Kirkby, lateral and dorsal views, hypotype 0-1127-5; Farley limestone, locality 106. (p. 89)

3—Bairda seligi Delo, lateral view, homoeotype 0-1117-2; Farley limestone, locality 106. (p. 90)

4–5—Bairdia seligi Delo, lateral and dorsal views, homoeotype 0-1128-2; lower shale of Lawrence formation, locality 191. (p. 90)

6–7—Bairdia seligi Delo, dorsal and lateral views, homoeotype 0-1128-2; Island Creek shale, locality 169. (p. 90)

8–9—Bairdia sp. 3, dorsal and lateral views, figured specimen 0-1118-3; lower shale of Lawrence formation, locality 240. (p. 92)

10—Bairdia sp. 1, lateral view of right valve, figured specimen 0-1117-5; Hushpuckney shale, locality 165. (p. 91)

11—Bairdia scholli Coryell and Booth, lateral view of narrow form, hypotype 0-1116-2; Eudora shale, locality 221. (p. 90)

12—Bairda kanwakensis Kellett, lateral view of broad form, homoeotype 0-1112-5; Heumader shale, locality 190. (p. 87)

13–14—Bairdia kanwakensis Kellett, lateral and dorsal views of narrow form, homoeotype 0-1113-1; Heumader shale, locality 190. (p. 87)

15–16—Bairdia sp. 4, dorsal and lateral views, figured specimen 0-11118-3; South Bend limestone, locality 236. (p. 92)

17, 32—Bairdia garrisonensis Upson, dorsal and lateral views, hypotype 0-1111-5; Winterset limestone, locality 103. (p. 85)

18–19—Bairdia beedei Ulrich and Bassler, lateral and dorsal views of broad form, homoeotype 0-1110-3; Wea shale, locality 178. (p. 83)

20—Bairdia beedei Ulrich and Bassler, lateral view of narrow form, homoeotype 0-1110-4; view of narrow form, homoeotype 0-1110-4; Wea shale, locality 178. (p. 83)

21–22—Bairdia oklahomaensis Harlton, lateral and dorsal views of narrow form, homoeotype 0-1113-5; Ladore formation, locality 157. (p. 88)

23–24—Bairdia oklahomaensis Harlton, dorsal and lateral views of broad form, homoeotype 0-1114-1; Ladore formation, locality 157. (p. 88)

25—Bairdia pompilioides Harlton, lateral view of immature molt, homoeotype 0-1114-5; South Bend limestone, locality 236. (p. 89)

26–27—Bairdia pompilioides Harlton, lateral and dorsal views, homoeotype 0-1114-4; Fontana shale, locality 103. (p. 89)

28–29—Bairdia sp. 7, lateral and dorsal views, figured specimen 0-1119-1; top of Pleasanton shale, locality 198. (p. 94)

30–31—Bairdia sp. 9, dorsal and lateral views, figured specimen 0-1128-4; Ladore shale, locality 59. (p. 94)

narrow, pointed. In dorsal view carapace broadly subfusiform, ends pointed, the anterior end pinched; greatest thickness central; valve contact in dorsal view essentially straight, the central portion gently depressed, offset very slightly to the left; valve contact in ventral view gently convex toward the right. Overlap obscure along dorsal margin, narrow along other margins. Surface smooth.

Length, 0.96 mm.; height, 0.40 mm.; thickness, 0.45 mm.

A. recurvata differs from *A. inornata*, n. sp., in being thicker and in possessing a downward-pointing hook at the anterior termination, instead of the high, sharply rounded anterior end, present in the latter. The new species is very much like Kellett's specimens of *A. typica*? Delo from the Lower Permian (Kellett, 1935, p. 140), but in her specimens the anterior projection terminates higher than in the Missouri specimens, and it is not a curved, downward-pointing hook. The holotype of *A. typica* Delo (1930, p. 175, pl. 13, fig. 12) is smaller than the Kansas or Missouri specimens of the genus, and it shows an extended overlap at midventer as seen in ventral view, rather than a broadly curved overlap. The holotype of *A. magna* Delo (1930, p. 175) is larger than Missouri specimens of the genus, and it has a more acuminate posterior end and a less well defined hook at the anterior end.

Occurrence.—Top of Pleasanton shale to Snyderville member of Oread formation, occurring in seven stratigraphic units.

Syntypes.—UM 0-1109-2, South Bend limestone, locality 236; 0-1109-3, Vilas formation, locality 235.

Genus BAIRDIA M'Coy, 1844

The genus *Bairdia* was almost universally believed to range from the Paleozoic to the Cenozoic until Scott (1944) pointed out differences in the muscle scar pattern of Paleozoic and Recent species. However, according to Sylvester-Bradley (1950), the illustrations used by Scott, which were taken from Sars (1926), do not correctly show the muscle scar pattern. Sylvester-Bradley concluded that there is no valid basis for separating the Recent and Paleozoic species which had been referred to *Bairdia*. A detailed account of the characteristics of *Bairdia*, and of the criteria useful in distinguishing its species from one another, was given by Kellett (1934).

BAIRDIA ACUMINATA Cooper
Plate 17, figures 13–16

Bairdia acuminata COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 40, pl. 1, figs. 27, 28; Bogota and Little Vermilion zones, Ill.

Bairdia verwiebei COOPER, 1946 (not Kellett), Illinois Geol. Survey Bull. 70, p. 52, pl. 4, figs. 7, 8; Shumway zone, Ill.

Length, 1.11 mm.; height, 0.51 mm.; thickness, 0.30 mm.

B. acuminata is most similar to *B. verwiebei* Kellett (1934, p. 129, pl. 16, figs. 1a–h) from the Deer Creek (Upper Pennsylvanian) and the Lower Permian of Kansas, but the former is typically somewhat thinner than the latter, especially in the mid-portion. Furthermore, the Illinois species has a somewhat shorter and more sinuous posterodorsal margin and a more sharply upturned posterior beak than does *B. verwiebei*. The anterior end in the Illinois species appears to be slightly lower on the average than in *B. verwiebei*. *B. acuminata* possibly occurs in Kansas in about the same beds as in Missouri, as Kellett mentioned in her description of *B. verwiebei* that specimens slightly different from *B. verwiebei* were found in beds which are classified within the Missourian series.

Occurrence.—Lane formation to base of Kanwaka formation, occurring in 17 stratigraphic units.

Homoeotypes.—UM 0-1109-4, Bonner Springs formation, locality 194; 0-1109-5, Vilas formation, locality 235.

BAIRDIA ALTIFRONS Knight
Plate 17, figures 1–4

Bairdia altifrons KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 324, pl. 43, figs. 6a, b; upper part of "Fort Scott" limestone (probably Pawnee), Mo.—— ?WARTHIN, 1930, Oklahoma Geol. Survey Bull. 53, p. 70, pl. 5, figs. 10a, b; Wewoka to Holdenville formations, Okla.—— JOHNSON, 1936, Nebraska Geol. Survey Paper 11, p. 42, pl. 4, figs. 4, 5; Stanton formation, Nebr.—— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 40, pl. 1, figs. 20–22; Seville to Shumway zones, Ill.

?Bairdia altifrons(?), KELLETT, 1934, Jour. Paleontology, vol. 8, p. 135, pl. 18, figs. 6a, b; Wewoka formation, Okla.

Bairdia hoxbarensis, HARLTON, 1929 (not Harl-

ton, 1927), Texas Univ. Bull. 2901, p. 154, pl. 3, figs. 1a–d; Canyon series, Texas.
Bairdia ampla, COOPER, 1946 (not Reuss), Illinois Geol. Survey Bull. 70, p. 40, pl. 1, figs. 45–49; Exline to Greenup zones, Ill.

Length, 1.13 mm. and 0.98 mm.; height, 0.61 mm. and 0.57 mm.; thickness, 0.47 mm. and 0.39 mm.

Individual variations in shape and overlap are characteristic, and probably result to some extent from differential pressures during and following fossilization. The species contains two forms, a narrow elongate type with a straight dorsal margin, and a shorter, broader type with a broadly convex dorsal margin. In each of the numerous samples in which *B. altifrons* occurs, both forms are represented. The most constant characters of the species are the straight or nearly straight dorsal margin, short, steep posterodorsal slope, acutely concave posterodorsal contact, prominent anterodorsal overlap, and subrectangular shape in dorsal view.

Warthin's identification of *B. altifrons*, an example of which was figured by Kellett and questionably referred by her to that species, is somewhat longer and much higher than the long form of *B. altifrons*, and it is much larger in all dimensions than the short form. *B. texana* Harlton, from the Cisco of Texas (1927, p. 210, pl. 33, fig. 9) is very much similar to the long form of *B. altifrons*, but Harlton's holotype is relatively narrower and is considerably longer than any specimens definitely identifiable as *B. altifrons*. *B. texana* is transitional in size between *B. altifrons* and Kellett's *B. chasae* (1934, p. 135, pl. 18, figs. 5a–d, pl. 19, figs. 5a–d), from the upper Shawnee of Kansas. *B. chasae* is slightly thinner and has slightly more attenuated ends than either *B. altifrons* or *B. texana*. Another species in this same group, *B. nevensis* Kellett (1934, p. 137, pl. 19, figs. 3a, b), is the largest species of the group, and its ends in dorsal view are less attenuated than in any of the related species.

Occurrence.—Top of Pleasanton to Kanwaka formation. *B. altifrons* is one of the most abundant species of *Bairdia* in the Missouri collections.

Hypotypes.—UM 0-1110-1 and 0-1110-2, Bonner Springs formation, locality 174.

BAIRDIA BEEDEI Ulrich & Bassler
Plate 18, figures 18–20

Bairdia beedei ULRICH & BASSLER, 1906, U. S. Nat. Mus. Proc., vol. 30, p. 161, pl. 11, figs. 19, 20; Cottonwood shales, Permian, Kans. —— ULRICH and BASSLER, 1923, Maryland Geol. Survey, Silurian vol., p. 319, text fig. 3. —— WARTHIN, 1930, Oklahoma Geol. Survey Bull. 53, p. 69, pl. 5, figs. 9a, b; Holdenville formation, Okla. —— UPSON, 1933, Nebraska Geol. Survey Bull. 8, 2d ser., p. 16, pl. 1, figs. 4a–c; Garrison shale, Permian, Kans. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 123, pl. 14, figs. 1a–h, 2; Upper Pennsylvanian and Permian, Kans. —— JOHNSON, 1936, Nebraska Geol. Survey Paper 11, p. 38, pl. 4, figs. 1, 2; Missourian series, Nebr. —— PAYNE, 1937, Jour. Paleontology, vol. 11, p. 282, pl. 38, figs. 9a, b; pl. 39, figs. 1a, b; Hayden Branch formation, Ind. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 41, pl. 1, figs. 35–40; Brereton to Shumway zones, Ill.
Bairdia beedei abrupta ULRICH & BASSLER, 1906, U. S. Nat. Mus. Proc., vol. 30, p. 161, pl. 11, figs. 21, 22; Cottonwood shales, Permian, Kans.
Bairdia hispida HARLTON, 1928, Jour. Paleontology, vol. 2, p. 140, pl. 21, fig. 14; Cisco series, Texas. —— HARLTON, 1929, Univ. Texas Bull. 2901, p. 155, pl. 3, figs. 2a, b; Canyon series, Texas. —— DELO 1930, Jour. Paleontology, vol. 4, p. 163, pl. 12, figs. 14a, b; Pennsylvanian (well cuttings), Texas.
Bairdia moorei KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 318, pl. 43, figs. 1a–c; "Upper Fort Scott" limestone (probably Pawnee), Mo. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 33 (no illustration); Nowata shale, Okla. —— CORYELL & BILLINGS, 1932, Am. Mid. Naturalist, vol. 13, p. 173, pl. 17, fig. 4; Wayland shale, Texas.
Bairdia hurwitzi CORYELL & BOOTH, 1933, Am. Mid. Naturalist, vol. 14, p. 262, pl. 3, figs. 8, 9; Graham formation, Texas. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 46, pl. 2, figs. 11–13; LaSalle and Newton zones, Ill.
Bairdia wrefordensis UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 22, pl. 2, figs. 5a, b; Wreford formation, Permian, Nebr.
Bairdia marmorea KELLETT, 1934, Jour. Paleontology, vol. 8, p. 127, pl. 15, figs. 1a–h; Upper Pennsylvanian to Lower Permian, Kans.
Bairdia hispida alta Bradfield, 1935, Bull. Am. Paleontology, vol. 22, p. 88, pl. 6, figs. 6a, b; Hoxbar group, Okla.
Bairdia longirostris Bradfield, 1935, Bull. Am. Paleontology, vol. 22, p. 89, pl. 6, figs. 11a, b; Daube limestone, Okla.

Carapace large, more or less elongate, tumid. Shape in lateral view subquadrate, greatest length ventral, greatest height slightly anterior; dorsal margin narrowly to broadly convex; anterodorsal slope gentle, long; posterodorsal slope steep, short; ven-

ter broadly and evenly convex; anterior end narrowly rounded, with termination at midheight; posterior beak bluntly terminated below midheight. In dorsal view carapace tumid medially, sides short, broadly rounded to almost straight, ends acuminate, tapering to blunt; valve contact in dorsal view essentially straight. Overlap broad except along anteroventral margin and around beak; in lateral view dorsal valve contact far below dorsal margin, straight, sloping backward; ventral valve contact considerably above ventral margin, concave, giving a sinuous character to the anteroventral contact. Surface smooth.

Length, 1.42 mm. and 1.37 mm.; height, 0.86 mm. and 0.77 mm.; thickness, 0.68 mm. and 0.65 mm.

B. beedei is characterized by the blunt beak, convex ventral margin, low dorsal valve contact, and high, concave ventral contact. There is considerable variation in form ratio and in the degree of taper in both lateral and dorsal views. In all samples which contained large numbers of specimens a wide gamut of gradations in form ratio is represented.

The holotype of *B. beedei*, from the Cottonwood shales of the Kansas Permian, is much smaller than the adult specimens of the species from the Pennsylvanian. However, as some of Kellett's specimens of the species from the Lower Permian are as large as the typical Pennsylvanian carapaces it is believed that the holotype is either from a depauperate faunule, or is a specimen affiliated with *B. marmorea* Kellett, which apparently consists of immature molts of *B. beedei*.

B. hurwitzi Coryell and Booth and *B. longirostris* Bradfield are placed in the synonymy of *B. beedei* for the first time. *B. hurwitzi* and *B. longirostris* are believed to be short and long forms, respectively, of *B. beedei*, although the types of neither species have been examined.

Occurrence.—Top of Pleasanton to base of Kanwaka shale. *B. beedei* is one of the most abundantly represented species in the Pennsylvanian of most areas. In Missouri, as elsewhere, it is found in a great many beds and at numerous localities.

Homoeotypes.—UM 0-1110-3 and 0-1110-4, Wea shale, locality 178.

BAIRDIA CORYELLI Roth & Skinner
Plate 17, figures 17–20

Bairdia coryelli ROTH & SKINNER, 1931, Jour. Paleontology, vol. 5, p. 48; new name for *B. ventricosa* Roth and Skinner, 1930. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 43, pl. 2, figs. 8–10, pl. 4, figs. 16–17; Shoal Creek to Greenup zones, Ill.

Bairdia nitida HARLTON, 1928, Jour. Paleontology, vol. 2, p. 139, pl. 21, figs. 12a, b; Hoxbar group, Okla. —— HARLTON, 1929, Texas Univ. Bull. 2901, p. 155, pl. 3, figs. 3a, b; Canyon series, Texas.

Bairdia blakei HARLTON, 1931, Jour. Paleontology, vol. 5, p. 163; new name for *B. nitida* Harlton, 1928. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 34 (no figure or description); Nowata shale, Okla.

Bairdia ventricosa ROTH & SKINNER, 1930, Jour. Paleontology, vol. 4, p. 352, pl. 28, figs. 12–14; McCoy formation, Colo.

Bairdia gibbosa PAYNE, 1937, Jour. Paleontology, vol. 11, p. 283, pl. 39, fig. 4; Hayden Branch formation, Ind.

Bairdia hooverae PAYNE, 1937 (not Kellett), Jour. Paleontology, vol. 11, p. 284, pl. 39, fig. 5; Hayden Branch formation, Ind.

Length, 1.15 mm.; height, 0.81 mm.; thickness, 0.75 mm.

Harlton's drawing of the holotype of *B. nitida* shows an angulation at the anterior end which is not present on the specimen itself. The name *B. nitida* was preoccupied and was therefore replaced by *B. blakei*. A few later authors were apparently misled by the drawing, and they have placed specimens of other species in *B. blakei*.

B. coryelli is similar to *B. hooverae* Kellett (1934, p. 126, pl. 14, figs. 5a, b), but her species is larger and proportionately thicker than the Colorado species. *B. hooverae*, unlike *B. coryelli*, is so tumid ventrally that the specimens rest easily on their ventral surfaces. Studies of the holotypes of *B. coryelli* and *B. blakei* Harlton show that they are conspecific with the Missouri specimens described above. Cooper's specimen of *B. crassa* Harlton (Cooper, 1946, p. 44, pl. 2, figs. 1, 2) is apparently closer to *B. coryelli* than to *B. crassa*. However, the more narrowly convex dorsal margin in Cooper's figured specimen differentiates it from *B. coryelli*. Payne's holotype of *B. gibbosa* and his hypotype of *B. hooverae* Kellett were not examined, but except for their slightly larger size they seem to be sufficiently similar to *B. coryelli* to be placed in the synonymy. *B. angusta* Cooper (1946,

p. 41, pl. 1, figs. 41–44), from much lower in the section than is *B. coryelli*, is thinner than the thinnest specimens of *B. coryelli*. Also, the posterior beak in Cooper's species is longer and slightly higher than in typical specimens of the Colorado species.

B. coryelli shows a wide range of variations in thickness, width of dorsal overlap, and degree of attenuation of the posterior end. The degree of curvature of the posterior beak is also a variable feature. However, in all specimens the carapace is tumid, the greatest thickness is slightly below midvalve, and the posterodorsal slope is long and relatively steep.

Occurrence.—Bethany Falls member of Swope formation to upper shale member of the Lawrence formation. The species is common only in the Spring Hill member of the Plattsburg formation, at localities 172 and 219. It was found in a large number of samples from many localities, but representation is in most cases sparse.

Homoeotypes.—UM 0-1110-5, Hickory Creek shale, locality 106; 0-1111-1, Spring Hill limestone, locality 172.

BAIRDIA CRASSA Harlton
Plate 19, figures 7–12

Bairdia crassa HARLTON, 1929, Texas Univ. Bull. 2901, p. 158, pl. 4, figs. 3a–c; Canyon series, Texas. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 33 (no figures or description); Nowata shale, Okla.

Bairdia crassa(?) KELLETT, 1934, Jour. Paleontology, vol. 8, p. 129, pl. 15, figs. 5a–g; Stanton and Iatan limestones, Kans.

Bairdia bradfieldi PAYNE, 1937, Jour. Paleontology, vol. 11, p. 283, pl. 39, figs. 3a, b; Hayden Branch formation, Ind.

Length, 0.99 and 1.10 mm.; height, 0.62 and 0.52 mm.; thickness, 0.47 and 0.54 mm.

Most of the Missouri specimens of *B. crassa* are rather badly weathered or abraded, as are many carapaces from the Iatan and Stoner limestones. The characters are distinctive, and the species is recognized particularly by the deeply incised dorsal margin, the long, steep posterodorsal slope, the very low, short, and pointed posterior beak, and the high, rather narrow anterior end. Both broad and narrow forms of the species are associated together in the three collections in which more than one specimen occurred. Specimens of *B. crassa* show considerable latitude in form ratio, thickness, and dorsal attenuation of the anterior end. *B. bradfieldi* Payne is apparently a narrow form of *B. crassa*. Reported occurrences of the species other than those here placed in synonymy are believed to be erroneous identifications. The wide areal distribution and probable narrow stratigraphic range of the species should make it valuable for correlations.

Occurrence.—Stanton formation, Stoner member, locality 225, five specimens. Iatan formation, locality 238, abundant; locality 233, four specimens; locality 230, one specimen.

Homoeotypes.—UM 0-1111-2 and 0-1111-3, Iatan formation, locality 230; 0-1111-4, Stoner limestone, locality 225.

BAIRDIA GARRISONENSIS Upson
Plate 18, figures 17, 32

Bairdia garrisonensis UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 20, pl. 1, figs. 10a–c; Garrison shale, Permian, Nebraska-Kansas line. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 134, pl. 17, figs. 5a–c; Deer Creek to Wreford formations, Upper Pennsylvanian to Lower Permian, Kans. —— ?SCOTT & BORGER, 1941, Jour. Paleontology, vol. 15, p. 354, pl. 49, fig. 19; Macoupin formation, Ill. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 45, pl. 2, figs. 14–18; Shumway zone, Ill.

Bairdia auricula BRADFIELD, 1935 (not Knight), Bull. Am. Paleontology, vol. 22, p. 89, pl. 6, figs. 13a, b; Hoxbar group, Okla.

Bairdia menardvillensis BRADFIELD, 1935 (not Harlton), Bull. Am. Paleontology, vol. 22, pl. 6, fig. 9; Hoxbar group, Okla. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 48, pl. 2, figs. 38–42; pl. 4, figs. 9–11; Gimlet and Exline zones, Ill.

Length, 1.56 mm.; height, 1.04 mm.; thickness, 0.72 mm.

The species is characterized by the highly arched dorsal margin, low posterior beak, steeply sloping nature of the straight dorsal contact, sinuous character of the ventral contact, and gently convex ventral margin. Bradfield's and Cooper's specimens identified as *B. menardvillensis* Harlton seem to belong to *B. garrisonensis*, and are placed in the synonymy. The Lower Permian specimens of *B. garrisonensis* figured by Upson and Kellett are somewhat larger than typical Pennsylvanian specimens.

Occurrence.—Ladore formation to Snyder-

ville member of the Oread formation. In but one Missouri sample, from the Wea member, was *B. garrisonensis* common. The species has been found in 14 stratigraphic units in Missouri.

Hypotype.—UM 0-1111-5, Winterset limestone, locality 103.

BAIRDIA HOXBARENSIS Harlton
Plate 19, figures 15–16, 29–30

Bairdia hoxbarensis HARLTON, 1927, Jour. Paleontology, vol. 1, p. 210, pl. 33, fig. 11; Upper Glenn formation, Okla. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 131, pl. 16, figs. 5a–c; Stanton formation to Wreford formation, Upper Pennsylvanian to Lower Permian, Kans. —— JOHNSON, 1936, Nebraska Geol. Survey Paper 11, p. 40, pl. 4, fig. 8; Wyandotte to Plattsburg formations, Nebr. —— PAYNE, 1937, Jour. Paleontology, vol. 11, p. 284, pl. 39, figs. 6a, b; Hayden Branch formation, Ind. —— SCOTT & BORGER, 1941, Jour. Paleontology, vol. 15, p. 354, pl. 50, fig. 7; Macoupin formation, Ill. —— ?COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 46, pl. 2, figs. 43, 44; Brereton to Shoal Creek zones, Ill.

Bairdia subelongata HARLTON, 1927, Jour. Paleontology, vol. 1, p. 210, pl. 33, fig. 11, upper Glenn formation, Okla.

Bairdia subelongata(?), KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 326, pl. 43, fig. 9; "Upper Fort Scott" limestone (probably Pawnee), Mo.

Bairdia haworthi KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 325, pl. 43, figs. 7a, b; "Upper Fort Scott" limestone (probably Pawnee), Mo. —— WARTHIN, 1930, Oklahoma Geol. Survey Bull. 53, p. 72, pl. 6, figs. 4a, b; Wetumka to Holdenville formations, Okla.

?Bairdia acetalata CORYELL & BILLINGS, 1932, Am. Mid. Naturalist, vol. 13, p. 173, pl. 17, fig. 5; Wayland shale, Texas. —— ?CORYELL & BOOTH, 1933, Am. Mid. Naturalist, vol. 14, p. 263, pl. 3, figs. 10, 11; Wayland shale, Texas.

Bairdia acetalata UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 17, pl. 1, fig. 5a; Garrison shale, Nebr.

Bairdia rogatzi CORYELL & SAMPLE, 1932, Am. Mid. Naturalist, vol. 13, p. 264, pl. 25, fig. 7; East Mountain shale, Texas.

Bairdia nebraskensis UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 18, pl. 1, figs. 6a, b; Wreford formation, Lower Permian, Nebr.

Bairdia glennensis? BRADFIELD, 1935 (not Harlton), Bull. Am. Paleontology, vol. 22, p. 81, pl. 5, figs. 12a, b; Deese group, Devils Kitchen limestone, Okla.

Bairdiacypris ardua COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 53, pl. 4, figs. 18, 19; Millersville and Shumway zones, Ill.

Bairdiacypris nebraskensis COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 54, pl. 4, figs. 28, 29; St. David to Exline zones, Ill.

Carapace of medium size, elongate, relatively thin. Shape in lateral view narrowly subovate, greatest length medial, greatest height anterior or posterior; dorsal margin straight to broadly convex, long; anterodorsal slope obscure, posterodorsal slope nearly straight, short, of moderate steepness; ventral margin concave medially, becoming convex toward ends; anterior margin moderately convex, broad for the genus; posterior end sharply rounded to blunt, narrow to moderately broad, terminating near midheight. In dorsal view carapace narrowly subelliptical, sides unevenly convex, ends acuminate; greatest thickness posterior; valve contact in dorsal view nearly straight, trending toward the left near ends. Overlap narrow to moderate along dorsal margin, prominent along midventer, narrow or obscure around ends. Surface smooth.

Length, 1.08 mm.; height, 0.50 mm.; thickness, 0.35 mm.

The species is represented by numerous specimens from many horizons, and individual variations are unusually wide. Both large and small forms and short and long specimens occur in most collections in which the species is common. Elongate forms have the more broadly convex dorsal margins. Slight deviation in elevation of the posterior end and considerable variation in its breadth are characteristic. The short, nearly straight posterodorsal slope, broad anterior end, blunt posterior beak, and the approximately medial terminations of both ends are constant characters of the species.

Occurrence.—Top of Pleasanton to base of Jackson Park member of the Kanwaka, present at most localities with typical marine faunules, common in many stratigraphic units.

Homoeotypes.—UM 0-1112-1, and 0-1112-2, Vilas shale, locality 235.

BAIRDIA KANSASENSIS Kellett
Plate 17, figures 9–12

Bairdia kansasensis KELLETT, 1934, Jour. Paleontology, vol. 8, p. 128, pl. 15, figs. 3a, b, 4a, b; Stanton and Elmdale formations, Pennsylvanian and Permian, Kans.

Bairdia monstrabilis COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 48, pl. 3, figs. 5–10; Bereton to Shumway zones, Ill.

Length, 1.33 mm. and 1.26 mm.; height,

0.71 mm. and 0.77 mm.; thickness, 0.51 mm. and 0.55 mm.

Both short and long forms are represented, and the stratigraphic limits of the two are mutually inclusive. The types of *B. kansasensis* show rather feebly developed ventral ridges, compared with the figured Missouri specimens of the species, but this difference is believed to be a function of preservation, judging from Missouri specimens with similarly weak development of the ridges. The posterior beak on the paratype is somewhat broader than on the Missouri carapaces, but this variation is thought not to be specific. Cooper does not describe the dorsal ridge on his *B. monstrabilis*, but this ridge is revealed in one of his figures (pl. 3, fig. 6). The Illinois types of *B. monstrabilis* and the figured specimens in the present report have similarly strong development of the ventral ridges. The diagnostic characters of *B. kansasensis* are the ventral ridges, the dorsal ridge on the left valve, and the evenly convex ventral margin.

Occurrence.—Hertha formation, locality 66, one specimen; ?Dennis formation, Canville member, locality 206, three specimens. Stark member of Dennis to Leavenworth member of Oread formation, common at many horizons and localities.

Homoeotypes.—UM 0-1112-3, Bonner Springs formation, locality 106; 0-1112-4, Raytown limestone, locality 196.

BAIRDIA KANWAKENSIS Kellett
Plate 18, figures 12–14

Bairdia kanwakensis KELLETT, 1935, Jour. Paleontology, vol. 9, p. 134, figs. 1a–d; Kanwaka shale, Kans.

Length, 1.15 and 1.01 mm.; height, 0.60 and 0.50 mm.; thickness, 0.43 and 0.42 mm.

The Missouri specimens have their anterior terminations slightly lower on the average than do the Kansas types of the species. This is not regarded as a specific difference, as some of the Missouri carapaces show an even higher anterior end than do Kellett's holotype and paratypes. *B. kanwakensis* differs from *B. whortoni* Kellett (1935, p. 135) only in having a slightly higher anterior end and a much less depressed posterodorsal contact. In *B. whortoni* the unusual depth of the posterodorsal contact is the result of an upward swelling on the posterodorsal margin of the right valve. *B. oklahomaensis* Harlton (1927, p. 209, pl. 33, fig. 7), which occurs in older beds than does *B. kanwakensis*, is much larger than that species, has flat rather than rounded sides, and has a lower anterior end than does *B. kanwakensis*. *B. pinnula* Coryell and Booth (1933, p. 263, pl. 3, fig. 14) ranges for the most part between the beds characterized by *B. oklahomaensis* and those in which *B. kanwakensis* has been found. When compared with *B. pinnula*, *B. kanwakensis* is somewhat smaller and more emaciated in appearance. Furthermore, the anterior end is higher in *B. kanwakensis* than in *B. pinnula*, and the posterior end is more acuminate. The same differences characterize *B. scholli* Coryell and Booth (1933, p. 264, pl. 4, figs. 3, 4), when compared with *B. kanwakensis*. *B. folgeri* Kellett (1935, p. 136, pl. 18, figs. 1e–f, 4a–f, pl. 19, figs. 1a–d, 4a–f, 6a–d) and *B. florenaensis* Upson (1933, p. 22, pl. 2, figs. 4a, b), both of which come from beds higher than those in which *B. kanwakensis* is found, differ from the latter species in being larger, and in having a lower, broader anterior end and a thicker posterior beak.

Occurrence.—Stranger formation, Haskell member, locality 228, abundant. Oread formation, Heumader member, locality 190, abundant.

Homoeotypes.—UM 0-1112-5 and 0-1113-1, Heumader shale, locality 190.

BAIRDIA MENARDENSIS Harlton
Plate 17, figures 29–33

Bairdia menardensis HARLTON, 1929, Texas Univ. Bull. 2901, p. 158, pl. 4, figs. 1a–d; Canyon series, Texas. —— DELO, 1930, Jour. Paleontology, vol. 4, p. 164, pl. 12, fig. 16; Pennsylvanian (well cuttings), Texas. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 33 (no description or figures); Nowata shale, Okla.

Length, 1.47 mm.; height, 0.90 mm.; thickness, 0.78 mm.

In some samples young molts are more abundant than adult carapaces, and differ so little in characters as to be almost miniature duplicates. All specimens are characterized by the rather high anterior end, tumid central portion, and acuminate ends

as seen in dorsal view. Acumination is somewhat variable, but distinctive in degree compared to that of similar species. *B. menardensis* is similar to *B. deloi* Kellett (1934, p. 126, pl. 14, figs. 6a, b), but the posterior beak is considerably lower and narrower in the former. *B. radlerae* Kellett (1934, p. 125, pl. 14, figs. 3a–c) has a higher anterior end and a lower posterior beak than *B. menardensis*, and its ends are more acuminate in both lateral and dorsal views. *B. menardvillensis* Harlton (*B. marginata*, 1929, p. 158, pl. 4, fig. 2), as contrasted with *B. menardensis*, has a straight instead of curved dorsal margin and a more broadly convex ventral margin.

Occurrence.—Quindaro member of Wyandotte formation to Snyderville member of Oread formation, occurring in eight stratigraphic units. The species is most abundant in the Pedee group and Lawrence formation.

Homoeotypes.—UM 0-1113-2, upper shale of Lawrence formation, locality 191; 0-1113-3 and 0-1113-4, lower shale of Lawrence formation, locality 240.

BAIRDIA OKLAHOMAENSIS Harlton
Plate 18, figures 21–24

Bairdia oklahomaensis HARLTON, 1927, Jour. Paleontology, vol. 1, p. 209, pl. 33, fig. 7; Glenn formation, Okla. —— HARLTON, 1929, Univ. Texas Bull. 2901, p. 156, pl. 3, figs. 5a, b; Canyon series, Texas. —— BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 85, pl. 5, figs. 9a, b; Hoxbar group, 175 feet above Confederate limestone, Okla. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 48, pl. 3, figs. 15–20; Fulda to Macoupin zones, Ill.

Bairdia auricula KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 319, pl. 43, figs. 3a, b; "Upper Fort Scott" limestone (probably Pawnee), Mo. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 34 (no figures or description); Nowata shale, Okla.

Length, 1.38 mm. and 1.41 mm.; height, 0.86 mm. and 0.75 mm.; thickness, 0.62 mm. and 0.61 mm.

Immature molts have the same general shape as adult specimens, except that the dorsal margin is less highly arched. Both broad and narrow forms of the species are represented in most samples which contain *B. oklahomaensis*. Characteristic features of the species are the large size, the dorsal arch, prominent posterodorsal bulge of the right valve, high anterior and low posterior terminations, uneven overlap, and the long flat sides. No other species of *Bairdia* has this combination of characters. *B. oklahomaensis* has been identified in a few reports not included in the synonymy above. In these cases it is believed that other species of the genus have been confused with *B. oklahomaensis*.

Occurrence.—Top of Pleasanton to top of Wea member of Cherryvale formation. *B. oklahomaensis* is most abundantly represented at the top of the Wea, but no specimen has been found above the Wea in Missouri. The species occurs in 17 samples, with eight stratigraphic units within its known Missouri range represented.

Homoeotypes.—UM 0-1113-5 and 0-1114-1, Ladore formation, locality 157.

BAIRDIA PERINCERTA Kellett
Plate 17, figures 21–23

Bairdia perincerta KELLETT, 1934, Jour. Paleontology, vol. 8, p. 132, pl. 16, figs. 6a–d; Howard and Burlingame limestones, Kans.

Length, 1.13 mm.; height, 0.69 mm.; thickness, 0.39 mm.

Characteristic features are the long, steep posterodorsal slope, attenuation of the ends in both lateral and dorsal views, the very broad dorsal apparent overlap, the flat sides, and the dorsal ridge. As for carapace shape and contour, the Missouri specimens match Kellett's specimens almost perfectly. Kellett's description of the ridge, which she describes as narrow, seems to refer only to the outer edge of the ridge. *B. powersi* Kellett (1934, p. 133, pl. 17, figs. 6a–e) is similar to *B. perincerta* in having about the same profile in dorsal view, and both species possess the dorsal ridge. However, *B. powersi* has a steeper posterodorsal slope, more thinly compressed ends in both lateral and dorsal views, and more tendency toward concavity along the ventral margin than does *B. perincerta*. *B. crassimarginata* Cooper (1946, p. 44, pl. 2, figs. 3–5) differs from *B. perincerta* in having a higher posterior beak and in lacking the dorsal ridge.

Occurrence.—Muncie Creek member of Iola formation to the Oread formation. The species is widely but rather sparsely distributed in the Missourian series and the

lower part of the Virgilian, and in the collections being studied it is in no case represented by more than four undoubted specimens in a sample.

Homocotypes.—UM 0-1114-2, Hickory Creek shale, locality 173; 0-1114-3, lower shale of Lawrence formation, locality 191.

BAIRDIA POMPILIOIDES Harlton
Plate 18, figures 25–27

Bairdia pompilioides HARLTON, 1928, Jour. Paleontology, vol. 2, p. 140, pl. 21, fig. 13; Hoxbar? group, Okla. —— HARLTON, 1929, Texas Univ. Bull. 2901, p. 154, pl. 2, fig. 7, pl. 3, fig. 8; Canyon series, Texas. —— WARTHIN, 1930, Oklahoma Geol. Survey Bull. 53, p. 70, pl. 5, figs. 11a, b; Holdenville formation, Okla. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 33 (no figures or description); Nowata shale, Okla. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 130, pl. 16, figs. 2–4; Stanton formation to Wreford formation, Upper Pennsylvanian to Lower Permian, Kans. —— BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 87, pl. 6, figs. 15a, b; Union Dairy and Confederate limestones, Okla. —— PAYNE, 1937, Jour. Paleontology, vol. 11, p. 284, pl. 39, figs. 7a, b, 8a, b; Hayden Branch formation, Ind. —— SCOTT & BORGER, 1941, Jour. Paleontology, vol. 15, p. 354, pl. 49, figs. 13, 14, Macoupin formation, Ill. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 49, pl. 3, figs. 39–43; Shoal Creek limestone to Greenup zone, Ill.

Bairdia subcitriformis KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 322, pl. 43, figs. 5a, b; "Pawnee" limestone (an Upper Marmaton limestone), Mo.

Length, 1.60 mm.; height, 0.88 mm.; thickness, 0.57 mm.

The only species similar to *B. pompilioides* is *B. peracuta* Warthin (1930, p. 71, pl. 6, figs. 2a, b). *B. pompilioides* is the larger of the two species, and has a more acutely upturned posterior beak and a shorter and steeper posterodorsal slope. It is possible that *B. peracuta* is an immature form of *B. pompilioides*.

Occurrence.—Ladore formation to Leavenworth member of Oread formation. The species was found in many samples, well distributed in the interval, but in no case does it occur in abundance.

Homoeotypes.—UM 0-1114-4, Fontana shale, locality 103; 0-1114-5, South Bend limestone, locality 236.

BAIRDIA REGULARIS Cooper
Plate 17, figures 34–39

Bairdia regularis COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 50, pl. 3, figs. 30–32; Exline zone, Ill.

Length, 1.51 mm.; height, 0.81 mm.; thickness, 0.53 mm.

The species differs from *B. reussiana* Kirkby (1858, p. 319, pl. 10, figs. 6, 6a) in having a lower, more blunt posterior end and a relatively greater carapace height. *B. schaurothiana* Kirkby (1858, p. 329, pl. 10, fig. 14) is very similar to *B. regularis*, but the posterior end of the former is higher and more acuminate, and the beak more upturned. *B. summa* Coryell and Billings (1932, p. 170, pl. 17, fig. 1) resembles *B. regularis*, but the former has a wider dorsal overlap and a more full-bodied contour in dorsal view, with blunter ends and a less distinctly subfusiform shape.

Occurrence.—Bonner Springs formation to Weston formation. The species is particularly abundant and persistent at and near the top of the Bonner Springs.

Homoeotypes.—UM 0-1115-1, Bonner Springs formation, locality 174; 0-1115-2 and 0-1115-3, Bonner Springs formation, locality 194.

BAIRDIA REUSSIANA Kirkby
Plate 17, figures 24–28;
Plate 18, figures 1, 2

Bairdia reussiana KIRKBY, 1858, Annals and Mag. Nat. History, vol. 2, p. 319, pl. 10, figs. 6, 6a. —— KIRKBY, 1859, Trans. Tynside Nat. Field Club, vol. 4, p. 146, text fig. 8, pl. 9, fig. 6; Durham limestone, Permian, England. —— UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 19, pl. 2, fig. 2a; Wreford formation, Lower Permian, Kans. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 132, pl. 17, figs. 1a–h, 4a, b; Pennsylvanian (?), Americus to Winfield formations, Lower Permian, Kans.

Bairdia maxeyi HARRIS & LALICKER, 1932, Am. Mid. Naturalist, vol. 13, p. 405, pl. 37, fig. 9; Garrison shale, Lower Permian, Kans.

Bairdia matfieldensis UPSON, 1933, Nebraska Geol. Survey Bull. 8, 2d ser., p. 18, pl. 1, figs. 7a, b; Matfield shale, Lower Permian, Nebr.

Carapace elongate, thin. Shape in lateral view subpolygonal, greatest length medial or slightly dorsal, greatest height posterior; dorsal margin straight; anterodorsal slope straight to gently concave, posterodorsal

slope concave, equal to the anterodorsal in length, but slightly steeper; ventral margin very gently concave, merging gradually in an upward swing with carapace ends; anterior end rounded, terminating about midheight; posterior beak broad, slightly upturned, ending about midheight. In dorsal view carapace subfusiform, ends acuminate; greatest thickness about central, whence sides converge in curvature or along almost plane surfaces toward the ends; valve contact in dorsal view nearly straight. Overlap narrow around the ends, prominent along ventral margin. In lateral view dorsal valve contact long, straight; ventral valve contact sinuous. Surface smooth.

Length, 1.40 mm.; height, 0.60 mm.; thickness, 0.39 mm.

Young molts have a higher anterior end than the adults, and in the former the dorsal margin and dorsal valve contact are convex instead of straight. Cooper's specimen of *B. kingii* Reuss (Cooper, 1946, p. 47, pl. 2, figs. 36, 37) seems close to *B. reussiana*, the only significant difference being that the former has more attenuated ends in dorsal view, giving a more definitely subfusiform profile than is present in *B. reussiana*. *B. regularis* Cooper (1946, p. 50, pl. 3, figs. 30–32) has a higher carapace and a lower posterior beak than does *B. reussiana*, and *B. schaurothiana* Kirkby (1858, p. 319, pl. 10, figs. 6, 6a) has a higher and thicker carapace than do the Kansas and Missouri specimens of *B. reussiana*.

Occurrence.—Winterset member of Dennis formation to lower shale of Lawrence formation. The species is sparsely represented in six widely separated beds.

Hypotypes.—UM 0-1115-4, Vilas formation, locality 235; 0-1115-5, lower shale of Lawrence formation, locality 228; 0-1127-5, Farley limestone, locality 106; 0-1128-1, South Bend limestone, locality 236.

BAIRDIA SCHOLLI Coryell and Booth
Plate 18, figure 11;
Plate 19, figures 1–6

Bairdia scholli CORYELL & BOOTH, 1933, Am. Mid. Naturalist, vol. 14, p. 264, pl. 4, figs. 3, 4; Wayland shale, Texas. —— ?COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 51, pl. 3, figs. 33, 34; Little Vermilion to Woodbury zones, Ill.

Bairdia amygdaliformis BRADFIELD. 1935, Bull. Am. Paleontology, vol. 22, p. 89, pl. 6, figs. 12a, b; Hoxbar group, Union Dairy limestone, Okla.

Bairdia pinnula COOPER (not Coryell & Booth), 1946, Illinois Geol. Survey Bull. 70, p. 49, pl. 3, figs. 13, 14; Shumway zone, Ill.

Length, 0.99 mm. and 0.97 mm.; height, 0.57 mm. and 0.51 mm.; thickness, 0.42 mm. and 0.37 mm.

Both broad and narrow forms are represented in *B. scholli*. This species is similar to a number of common species of *Bairdia*. It is smaller than *B. oklahomaensis* Harlton (1927, p. 209, pl. 33, fig. 7), and it lacks the flat sides, the highly arched dorsal margin, and the prominent posterodorsal bulge of the latter. *B. folgeri* Kellett (1934, p. 136, pl. 18, figs. 1e–f, 4a–f; pl. 19, figs. 1a–d, 4a–f, 6a–d) and *B. florenaensis* Upson (1933, p. 22, pl. 2, figs. 4a, b) are similar to *B. scholli*, but they are larger than that species and have broader posterior beaks. *B. kanwakensis* Kellett (1935, p. 134, text figs. 1a–d) is smaller than *B. scholli* and has a higher anterior termination. Cooper's specimens of *B. scholli* (1946, p. 51, pl. 3, figs. 33, 34) possibly belong to that species but they have higher, more upturned posterior beaks and higher anterior ends than most typical specimens of the species. *B. recta* Harlton (1929, p. 159, pl. 4, figs. 4a–d) differs from *B. scholli* only in having a higher and broader posterior beak. The reticulation pits described by Harlton are believed by the present author to be abrasive markings, a conclusion suggested as a possibility by Harlton.

Occurrence.—Winterset member of Dennis formation to base of Kanwaka shale, present in many samples.

Hypotypes.—UM 0-1116-2, Eudora shale, locality 221; 0-1116-3, Block limestone, locality 250; 0-1116-4, Block limestone, locality 250; 0-1116-5 and 1117-1, Farley limestone, locality 106.

BAIRDIA SELIGI Delo
Plate 18, figures 3–7

Bairdia seligi DELO, Jour. Paleontology, vol. 4, p. 165, pl. 12, fig. 17; Pennsylvanian (well cuttings), Texas.

Length, 1.08 mm.; height, 0.59 mm.; thickness, 0.33 mm.

The holotype of the species is slightly

thicker and somewhat more tapered in dorsal view than the Missouri specimens. For the present, these differences are not believed to be specific. *B. seligi* resembles immature molts of *B. beedei* Ulrich and Bassler (1906, p. 16, pl. 11, figs. 19, 20), but it differs from them in having a somewhat more attenuated posterior beak, as seen in lateral view, and a narrower apparent dorsal overlap.

Occurrence.—Wyandotte formation, Farley limestone member, one specimen.

Homoeotypes.—UM 0-1117-2, Farley limestone, locality 106; 0-1128-2, lower shale of Lawrence formation, locality 191; 0-1128-3, Island Creek shale, locality 169.

BAIRDIA SEMINALIS Knight
Plate 17, figures 5–8

Bairdia seminalis KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 320, pl. 43, figs. 2a–d; "Lower Fort Scott" to "Upper Fort Scott" limestones (probably Higginsville to Pawnee limestones), Mo. —— CORYELL & SAMPLE, 1932, Am. Mid. Naturalist, vol. 13, p. 262, pl. 25, fig. 14; Mineral Wells formation, Texas. —— KELLETT, 1934, Jour. Paleontology, vol. 8, p. 127, pl. 15, figs. 2a–c; Stanton formation to Neva limestone, Upper Pennsylvanian to Lower Permian, Kans. —— JOHNSON, 1936, Nebraska Geol. Survey Paper 11, p. 40, pl. 4, fig. 3; Westerville limestone to Stanton formation, Nebr. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 51, pl. 3, figs. 27–29; Pokeberry to Woodbury zones, Ill.

Bairdia crassa DELO, 1930 (not Harlton), Jour. Paleontology, vol. 4, p. 164, pl. 12, fig. 15; Pennsylvanian (well cuttings), Texas. —— DELO. 1931, Washington Univ. Studies, n. ser. Sci. and Tech., no. 5, p. 49, pl. 4, fig. 9; Pennsylvanian (well cuttings), Kans.

Bairdia samplei CORYELL & BOOTH, 1933, Am. Mid. Naturalist, vol. 14, p. 264, pl. 3, figs. 12, 13; Wayland shale, Texas.

Bairdia tumida UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 21, pl. 2, figs. 3a–c; Cottonwood-Florena contact, Lower Permian, Nebr.

Bairdia blakei, BRADFIELD, 1935 (not Harlton), Bull. Am. Paleontology, vol. 22, p. 84, pl. 6, figs. 1a, b; Hoxbar and Deese groups, Okla.

Length, 0.95 mm. and 0.95 mm.; height, 0.63 mm. and 0.54 mm.; thickness, 0.50 mm. and 0.48 mm.

Immature molts have more narrowly convex dorsal margins and more acuminate posterior beaks than do mature specimens. These small specimens are differentiated from neanic forms of other species by the unusually broad apparent dorsal overlap. The form ratio of *B. seminalis* varies between rather wide limits. A large percentage of carapaces are crushed or otherwise distorted, a condition which alters the original tumidity and apparent overlap.

Diagnostic characters of *B. seminalis* are the subovate shape in lateral view, lack of the usual degree of angularity in valve contacts and margins, pronounced apparent dorsal overlap, the low, blunt posterior beak, and the swollen appearance of the right valve in the vicinity of the sunken hinge line.

The species most similar to *B. seminalis* is *B. compacta* Geis (1932, p. 177, pl. 25, figs. 14a–d), from the Salem limestone of the Mississippian. In Geis' species the dorsal apparent overlap and the depressed portion of the dorsal contact are narrower than are these features in *B. seminalis*. Furthermore, the dorsal margin in *B. compacta* is more broadly convex than in the Pennsylvanian and Lower Permian species.

Occurrence.—Top of Pleasanton shale to Heumader member of Oread formation. *B. seminalis* is the most abundantly represented species of *Bairdia* in the Missouri collections.

Hypotypes.—UM 0-1117-3, Hushpuckney shale, locality 165; 0-1117-4, Bethany Falls limestone, locality 205.

BAIRDIA sp. 1
Plate 18, figure 10

Carapace medium in size, elongate, acuminate, of average thickness. Shape in lateral view subfusiform, greatest length medial, greatest height slightly anterior; dorsal margin rounded, dorsal slopes gently inclined, broadly and equally concave; ventral margin of right valve concave, ventral slopes long and broadly convex; anterior end higher than mid-valve, narrowly rounded; posterior end attenuated, bluntly pointed, very slightly upturned, terminating at about midheight. In dorsal view carapace nearly symmetrical, subfusiform; ends tapered and pointed; greatest thickness central or slightly posterior. Overlap and contact outline unknown, as only a single right valve is represented. Surface of right valve slightly depressed along antero- and posteroventral borders of the tumid medial portion of the valve.

Length, 1.52 mm.; height, 0.60 mm.; thickness, 0.30 mm. (single valve).

Only a single right valve is represented, and it is unlike the right valve of any Carboniferous species of *Bairdia* known to the author.

Occurrence.—Hushpuckney member of Swope formation, locality 165, one right valve.

Figured specimen.—UM 0-1117-5, Hushpuckney shale, locality 165.

BAIRDIA sp. 2
Plate 19, figures 13, 14

Carapace of medium size, longer than high, tumid. Shape in lateral view subpolygonal, greatest length ventral, greatest height medial or slightly posterior; dorsal margin short, high, nearly straight; anterodorsal slope moderately long, straight; posterodorsal slope long, gently sinuous; ventral margin concave, merging with moderately upswept ventral slopes; anterior end relatively narrow, terminating about midheight; posterior beak blunt, ending slightly below midheight. In dorsal view carapace broadly subfusiform, sides rounded, ends pointed and slightly compressed; greatest thickness medial; valve contact in dorsal view straight, situated well to the right. Dorsal overlap broad, apparent; overlap along other margins narrow, true; dorsal contact in lateral view nearly straight, essentially parallel to carapace length. Dorsal margin of left valve ornamented by a ridge which slopes gently toward dorsal contact; ventral surface marked by narrow, inconspicuous curved ridges on each valve, located in medial third; surface otherwise unornamented.

Length, 1.29 mm.; height, 0.65 mm.; thickness, 0.60 mm.

B. sp. 2 bears the dorsal ridge characteristic of *B. kansasensis* Kellett (1934, p. 128, pl. 15, figs. 3a, b, 4a, b), *B. powersi* Kellett (1934, p. 133, pl. 17, figs. 6a–e), and *B. perincerta* Kellett (1934, p. 132, pl. 16, figs. 6a–d). However, in other probably more significant carapace characters there is little resemblance between the Missouri specimen and the three Kansas species. *B.* sp. 2 is perhaps most similar to *B.* sp. 4 of the report, but the former has a thicker and longer carapace, and a broader posterior beak. The ventral ridges which are present on *B.* sp. 2 are obscure or undeveloped on *B.* sp. 4.

Occurrence.—Plattsburg formation, Spring Hill member, locality 172, one specimen.

Figured specimen.—UM 0-1118-1, Spring Hill limestone, locality 172.

BAIRDIA sp. 3
Plate 18, figures 8, 9

Carapace average in size, slightly longer than high, compact. Shape in lateral view subovate, greatest length ventral, greatest height slightly anterior; dorsal margin short, high, rounded; anterodorsal margin straight, moderately sloping; posterodorsal slope nearly straight, steep; ventral margin gently convex, merging with short ventral slopes; anterior end broadly and evenly rounded; posterior end blunt, terminating well below midheight. In dorsal view carapace broadly subfusiform, sides rounded evenly, ends short, blunt; greatest thickness slightly posterior; valve contact in dorsal view straight. Overlap wide, but mostly apparent rather than true along dorsal margin and dorsal slopes, prominent along midventer; dorsal contact in lateral view gently curved, slightly depressed. Dorsal surface of left valve longitudinally swollen; ventral surface of right valve marked by an inconspicuous curved ridge in mid-portion; ventral surface of left valve similarly but more obscurely ornamented; surface otherwise smooth.

Length, 1.15 mm.; height, 0.72 mm.; thickness, 0.53 mm.

B. sp. 3 is perhaps most similar to *B. kansasensis* Kellett (1934, p. 128, pl. 15, figs. 3a, b, 4a, b), but the former has broader dorsal overlap and much less attenuated ends in both lateral and dorsal views. Furthermore, on nearly all specimens of *B. kansasensis* the longitudinal ventral ridges are more pronounced.

Occurrence.—Lower shale of the Lawrence formation, locality 240, one specimen.

Figured specimen.—UM 0-1118-2, lower shale member of Lawrence formation, locality 240.

BAIRDIA sp. 4
Plate 18, figures 15, 16

Carapace of average size, moderately elongate and acuminate. Appearance in lateral view somewhat swollen; shape sub-

polygonal, greatest length ventral, greatest height medial or slightly anterior; dorsal margin short, straight, merging smoothly with marginal slopes; anterodorsal slope gently concave; posterodorsal slope convex above, acutely concave and steep below; ventral margin straight to broadly convex; antero- and posteroventral margins about equal in length and degree of slope; anterior end rather narrow, rounded, terminating about midheight; posterior beak short, small, narrow, upturned, terminating just below midheight. In dorsal view carapace subfusiform, very thin, sides evenly rounded, ends tapered; left valve much deeper and higher than the right; valve contact in dorsal view straight, slightly and narrowly incised medially. Overlap very wide and apparent rather than true along dorsal margin, prominent anterodorsally and at mid-venter, where the left valve is thickened and covers right valve margin; dorsal valve contact in lateral view straight, posteriorly inclined; ventral valve contact sharply sinuous. Upper surface of left valve traversed longitudinally by a low, thin ridge.

Length, 1.23 mm.; height, 0.66 mm.; thickness, 0.47 mm.

Species closely related to *B.* sp. 4 are not known to the author. *B. kansasensis* Kellett (1934, p. 128, pl. 15, figs. 3a, b, fig. 4a, b), *B. perincerta* Kellett (1934, p. 132, pl. 16, figs. 6a–d), and *B. powersi* Kellett (1934, p. 133, pl. 17, figs. 6a–e) have a similar ridge along the top of the left valve, but none of them is closely similar to *B.* sp. 4 in other respects.

Occurrence.—South Bend member of the Stanton formation, locality 236, two specimens.

Figured specimen.—UM 0-1118-3, South Bend limestone, locality 236.

BAIRDIA sp. 5
Plate 19, figures 17, 18

Carapace small for the genus, elongate, thin. Shape in lateral view elongate-subelliptical, greatest length medial, greatest height slightly anterior; dorsal margin gently convex, merging imperceptibly with anterodorsal slope; posterodorsal slope steeper than the anterodorsal, convex above, concave below; ventral margin concave medially, convex toward terminations; anterior end moderately and evenly rounded; posterior beak blunt, broad, slightly upturned. In dorsal view carapace subfusiform, sides gently rounded, ends acuminate and pointed; greatest thickness medial; valve contact in dorsal view nearly straight. Overlap narrow except along mid-venter, where the left valve extends conspicuously over the right. Surface smooth.

Length, 1.14 mm.; height, 0.42 mm.; thickness, 0.32 mm.

B. sp. 5 is narrower than *B. hoxbarensis* Harlton (1927, p. 210, pl. 3, fig. 11), and has a narrower and more definitely upturned beak than that species. *Bairdiacypris ardua* Cooper (1946, p. 53, pl. 4, figs. 18, 19), which with the restricted definition of *Bairdiacypris* is placed in *Bairdia*, is much higher than *B.* sp. 5 and has a much broader posterior end than that species.

Occurrence.—Quindaro shale member of the Wyandotte formation, locality 167, one specimen.

Figured specimen.—UM 0-1118-4, Quindaro shale, locality 167.

BAIRDIA sp. 6
Plate 19, figures 25, 26

Carapace small to medium in size, elongate, thin. Shape in lateral view narrowly subovate, greatest length medial or slightly ventral, greatest height posterior; dorsal margin very broadly convex, with a slight forward tilt; anterodorsal slope obscure; posterodorsal slope convex above, gently concave near base; ventral margin concave medially, convex near ends; anterior end broadly convex, terminating slightly above midheight; posterior end narrow, acuminate, terminating below midheight. In dorsal view carapace subfusiform, sides very broadly convex, ends attenuated and pointed; greatest thickness immediately behind carapace center; valve contact in dorsal view essentially straight except slightly in front of midlength, where the contact line is gently convex toward the right. Overlap moderate and constant along dorsal margin, prominent along mid-venter, obscure along other margins. Surface smooth.

Length, 1.01 mm.; height, 0.48 mm.; thickness, 0.30 mm.

B. sp. 6 differs from *B. altifrons* Knight (1928, p. 324, pl. 43, figs. 6a, b) and its

close relatives in having a more strongly subfusiform rather than a subquadrate shape in dorsal view. The posterior end is narrower and lower, and the posterodorsal slope is longer and more convex, than in *B. hoxbarensis* Harlton (1927, p. 211, pl. 33, fig. 12). The upper part of the posterior end of the holotype of *B. hoxbarensis* is broken away, giving the effect of a narrower posterior end than the specimen had originally. *Bairdiacypris acuminata* Cooper (1946 p. 53, pl. 4, figs. 24, 25), which is believed to be a species of *Bairdia*, has a much broader posterior beak than does *B.* sp. 6. Cooper's holotype is crushed and slightly distorted, and it quite possibly is *Bairdia hoxbarensis* Harlton.

Occurrence.—Hertha formation, locality 102, one specimen.

Figured specimen.—UM 0-1118-5, Hertha formation, locality 102.

BAIRDIA sp. 7
Plate 18, figures 28, 29

Carapace of average size for the genus, symmetrical, elongate, tumid. Shape in lateral view subpolygonal, greatest length dorsal, greatest height medial; dorsal margin moderately convex; dorsal slopes concave, of equal length; ventral margin evenly convex, swinging upward conspicuously toward both carapace terminations; ends attenuated, pointed, upturned. In dorsal view carapace broad, medially full, the ends acuminate and slightly pinched; greatest thickness about central. Overlap largely destroyed by weathering or abrasion. Character of surface unknown.

Length, 1.31 mm.; height, 0.77 mm.; thickness, 0.63 mm.

B. sp. 7 is recognized by its conspicuously upturned ends, both of which show a high degree of attenuation in lateral and dorsal views. No other species of *Bairdia* is as symmetrical in side view as is *B.* sp. 7, and at the same time characterized by such conspicuous upsweep of both ends. The carapace described above is badly abraded, but it apparently differs from the Kansas species, *B. deloi* Kellett (1934, p. 126, pl. 14, figs. 6a, b) in being much smaller and narrower. The ends are higher and more pointed in the Missouri specimen, and in dorsal view the ends are more attenuated and compressed, when compared with the Kansas species.

Occurrence.—Top of Pleasanton shale, one specimen.

Figured specimen.—UM 0-1119-1, top of Pleasanton shale, locality 198.

BAIRDIA sp. 8
Plate 19, figures 21, 22

Carapace small, elongate, moderately tumid. Shape in lateral view narrowly subpolygonal, greatest length ventral, greatest height anterior; dorsal margin essentially straight; anterodorsal slope straight, long; posterodorsal slope straight in upper part, concave near base; ventral margin gently concave; anterior end low, narrow, evenly rounded; posterior end blunt, very slightly upturned, terminating below midheight. In dorsal view carapace subfusiform, sides gently rounded; anterior end more acuminate than the posterior, but less sharply pointed; greatest thickness slightly posterior; valve contact in dorsal view nearly straight. Overlap broad and mostly apparent along dorsal margin and dorsal slopes, narrower but mostly true along rest of margin. Surface smooth.

Length, 1.22 mm.; height, 0.67 mm.; thickness, 0.51 mm.

The specimen described above is distinguished by its narrow carapace, low blunt ends, and broad apparent overlap along the dorsal margin and dorsal slopes. The general shape is suggestive of the genus *Bairdiacypris*, but the broad apparent dorsal overlap and the presence of a slightly upturned posterior beak are more characteristic of *Bairdia*.

Occurrence.—Ladore shale, locality 59, one specimen.

Figured specimen.—UM 0-1128-5, Ladore shale, locality 59.

BAIRDIA sp. 9
Plate 18, figures 30, 31

Carapace large, elongate, relatively thin. Shape in lateral view subpolygonal, greatest length ventral, greatest height medial; dorsal margin short, nearly straight; anterodorsal slope slightly inclined, gently concave; posterodorsal slope long, moderately inclined; ventral margin straight, ventral slopes upswung; anterior end narrowly

rounded, terminating above midheight; posterior beak long, attenuated, pointed, slightly upturned. In dorsal view carapace subfusiform, sides unevenly rounded, ends long and tapering; valve contact in dorsal view nearly straight; greatest thickness slightly anterior. Overlap uneven, wide but only apparent along dorsal margin, prominent along mid-venter; dorsal valve contact in lateral view straight, sloping gently toward posterior. Surface smooth.

Length, 1.74 mm.; height, 0.86 mm.; thickness, 0.57 mm.

B. pompilioides Harlton (1928, p. 140, pl. 21, fig. 13) is somewhat similar to *B.* sp. 9, but the former has a much steeper and shorter posterodorsal slope and a more acutely upturned posterior beak.

Occurrence.—Ladore formation, locality 59, one specimen.

Figured specimen.—UM 0-1128-4, Ladore formation, locality 59.

Genus BAIRDIACYPRIS Bradfield, 1935

According to Bradfield's description, *Bairdiacypris* should include only those species with essentially straight dorsal, anterodorsal, and posterodorsal slopes, and with ends which are below midheight. As the dorsal slopes are described as being short, they would necessarily also have to be steep in keeping with the low position of the anterior and posterior ends. The overlap is given as narrow and even, and the ventral margin is concave.

On the basis of these carapace characters, at least one Pennsylvanian species heretofore placed only in *Bairdia*, should be transferred to *Bairdiacypris*, namely, *Bairdia glennensis* Harlton, of which the holotype and the figured Missouri specimen are abraded representatives. Specimens with better preservation were figured by Kellett (1935, p. 133, pl. 18, figs. 4a–e). These show the angularity which results from straight dorsal margin and dorsal slopes, and the low ends, even overlap, and concave ventral margin characteristic of *Bairdiacypris*. Kellett recently stated (oral communication) that *B. glennensis* should be placed in *Bairdiacypris* on the basis of its general carapace characters.

Bythocypris haydenbranchensis Payne (1937) qualifies for inclusion in *Bairdiacypris*, in spite of its convex ventral margin. According to the original description of *Bairdiacypris*, the ventral margin is concave. However, slight convexity or concavity of the ventral margin is not of generic importance in the related genera, *Bairdia* and *Bythocypris*.

Cooper (1946) has placed several species in *Bairdiacypris* which apparently should be retained in *Bairdia*, namely, *Bairdiacypris ardua* Cooper, *B. nebraskensis* (Upson), *B. acuminata* Cooper, and *B. trojana* (Wilson). These species lack the low ends and the angular appearance in lateral view which necessarily accompany *Bairdiacypris*. The above species, together with *Bairdia hoxbarensis*, are characterized by a very gently convex dorsal margin, an obscure anterodorsal slope, broad ends in lateral view, and narrow and even overlap. It is possible that this group is not congeneric with the more typical forms of *Bairdia*.

BAIRDIACYPRIS DELOI Bradfield
Plate 19, figures 19–20

Bairdiacypris deloi BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 93, pl. 7, figs. 8a, b; Union Dairy limestone, Okla. —— COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 53, pl. 4, figs. 22, 23; "Centralia" zone, Ill.

Length, 1.22 mm.; height, 0.57 mm.; thickness, 0.45 mm.

B. cf. *deloi* Bradfield (1935, p. 93, pl. 7, figs. 9a, b) is much thicker and less subfusiform in dorsal view than are typical carapaces of *B. deloi*, and the former has a slight forward tilt in the dorsal margin and dorsal valve contact which are not present in *B. deloi*. Cooper's specimen identified as *Bairdiacypris haydenbranchensis* (Payne) (Cooper, 1946, p. 54, pl. 4, figs. 20, 21) appears to be conspecific with Bradfield's *B.* cf. *deloi*, and neither seems to be conspecific with *Bythocypris haydenbranchensis* Payne (1937, p. 285, pl. 40, figs. 1a, b), a form which according to Cooper should be classified with *Bairdiacypris*. The present author agrees with Cooper that Payne's species is a *Bairdiacypris*, but the species differs from Cooper's specimen of *B. haydenbranchensis* and *B.* cf. *deloi* in having a convex instead of concave ventral margin. Furthermore, *B. haydenbranchensis* has a much thinner profile in dorsal view than

does Cooper's form identified with the species, and the former has more acuminate ends in lateral view than does Cooper's specimen. *Bairdiacypris* sp. 1 of the present report differs from *B.* cf. *deloi* and Cooper's specimen of *B. haydenbranchensis* (Payne) only in dorsal profile, the former having a much thinner profile in dorsal view than do the latter two forms. *Bairdia shideleri* Delo (1930, p. 167, pl. 13, fig. 2), which was referred to *Bairdiacypris* by Cooper (1946, p. 54), has a more rounded appearance in lateral view than does *B. deloi*, and the dorsal margin on the former is shorter than on the latter. *B. glennensis* (Harlton) (1927, p. 210, pl. 33, fig. 10) has a posterior beak, and a slightly concave margin in the lower part of the posterior slope, features not present in *B. deloi*.

Occurrence.—Ladore formation to Leavenworth member of Oread formation. The species occurs in 11 stratigraphic units in the interval.

Hypotype.—UM 0-1119-2, Island Creek shale, locality 169.

BAIRDIACYPRIS GLENNENSIS (Harlton)
Plate 19, figures 27, 28

Bairdia glennensis HARLTON, 1927, Jour. Paleontology, vol. 1, p. 210, pl. 33, fig. 10; upper Glenn formation, Okla. —— ?KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 325, pl. 43, figs. 8a, b; "Pawnee" formation (probably higher than the true Pawnee, in the upper part of the Marmaton group), Mo. —— KELLETT, 1935, Jour. Paleontology, vol. 9, p. 133, pl. 18, figs. 4a–e; Stanton to Elmdale formations, Upper Pennsylvanian to Lower Permian, Kans.

Length, 1.29 mm.; height, 0.52 mm.; thickness, 0.34 mm.

EXPLANATION OF PLATE 19

All figures ×28

FIGS. *1*—*Bairdia scholli* Coryell and Booth, lateral view of broad form, hypotype 0-1116-5; Farley limestone, locality 106. (p. 90)
2—*Bairdia scholli* Coryell and Booth, lateral view of narrow form, hypotype 0-1116-3; Block limestone, locality 250. (p. 90)
3–4—*Bairdia scholli* Coryell and Booth, dorsal and lateral views of broad form, hypotype 0-1116-4; Block limestone, locality 250. (p. 90)
5–6—*Bairdia scholli* Coryell and Booth, lateral and dorsal views of broad form, hypotype 0-1117-1; Farley limestone, locality 106. (p. 90)
7, 9—*Bairdia crassa* Harlton, lateral and dorsal views of broad form, homoeotype 0-1111-2; Iatan limestone, locality 230. (p. 85)
8, 10—*Bairdia crassa* Harlton, lateral and dorsal views of narrow form, homoeotype 0-1111-3; Iatan limestone, locality 230. (p. 85)
11–12—*Bairdia crassa* Harlton, dorsal and lateral views of broad form, homoeotype 0-1111-4; Stoner limestone, locality 225. (p. 85)
13–14—*Bairdia* sp. 2, dorsal and lateral views, figured specimen 0-1118-1; Spring Hill member, locality 172. (p. 92)
15–16—*Bairdia hoxbarensis* Harlton, dorsal and lateral views, homoeotype 0-1112-1; Vilas formation, locality 235. (p. 86)
17–18—*Bairdia* sp. 5, lateral and dorsal views, figured specimen 0-1118-4; Quindaro shale, locality 167. (p. 93)
19–20—*Bairdiacypris deloi* Bradfield, dorsal and lateral views, hypotype 0-1119-2; Island Creek shale, locality 169. (p. 95)
21–22—*Bairdia* sp. 8, dorsal and lateral views, figured specimen 0-1128-5; Ladore shale, locality 59. (p. 94)
23–24—*Bairdiacypris* sp. 1, dorsal and lateral views, figured specimen 0-1119-4; Stranger formation, locality 228. (p. 98)
25–26—*Bairdia* sp. 6, lateral and dorsal views, figured specimen 0-1118-5; Hertha formation, locality 102. (p. 93)
27–28—*Bairdiacypris glennensis* (Harlton), dorsal and lateral views, homoeotype 0-1119-3; Spring Hill limestone, locality 219. (p. 96)
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31, 33, 34—*Fabalicypris* sp. 1, dorsal, lateral and ventral views, figured specimen 0-1126-1; top of Pleasanton shale, locality 60. (p. 104)
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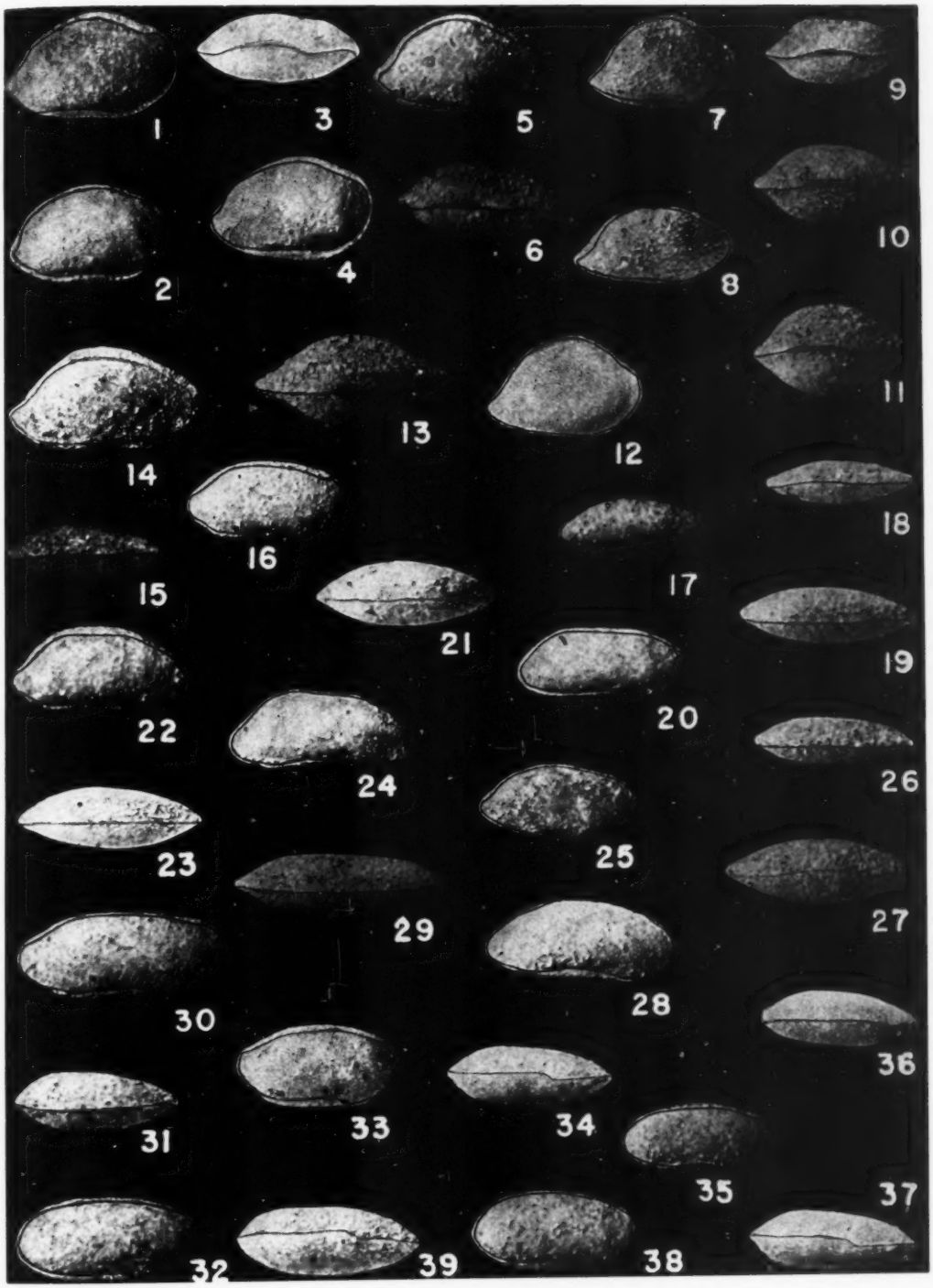
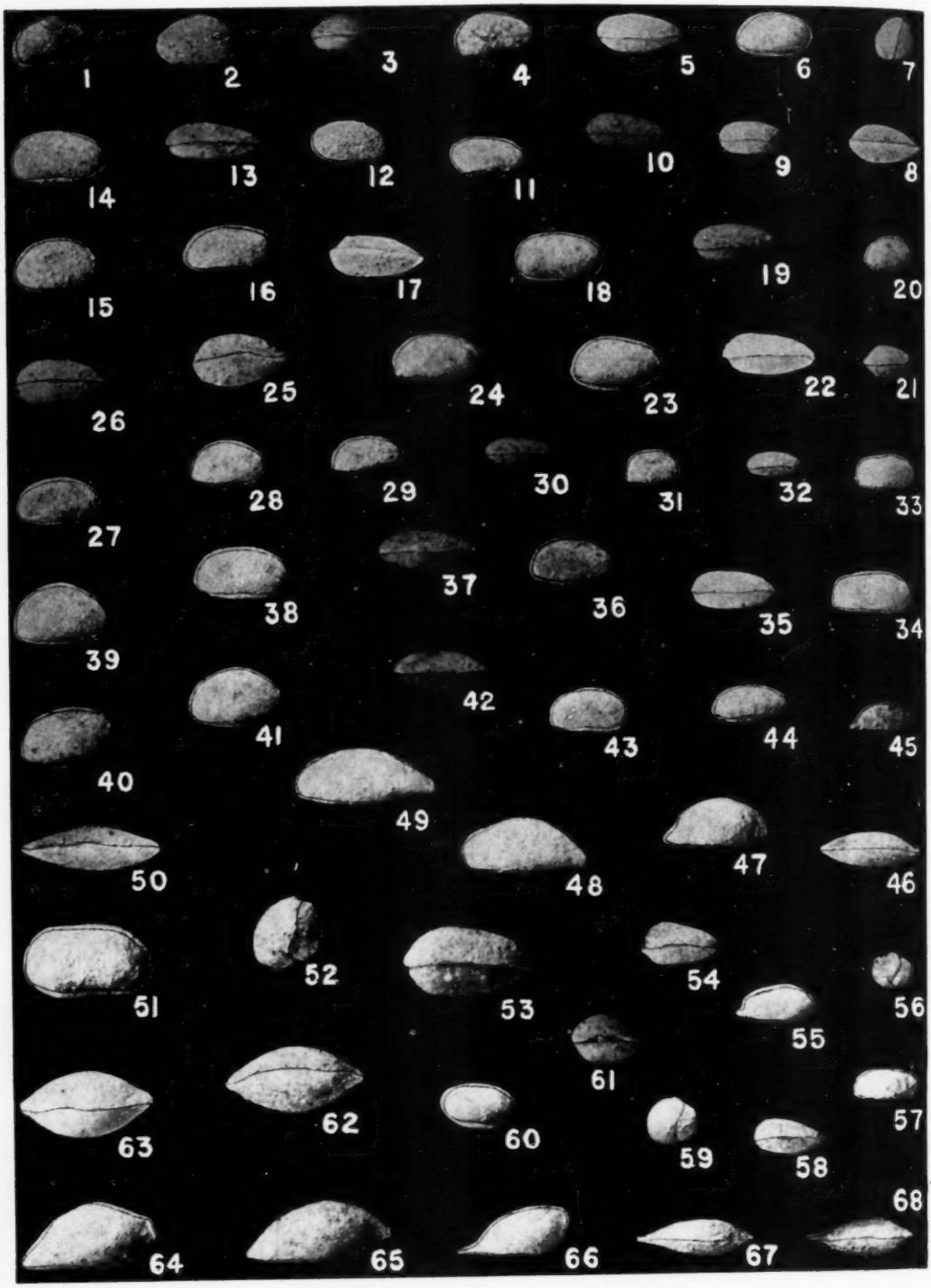
37–38—*Fabalicypris subelliptica* Cordell, n. sp., lateral and ventral views, holotype 0-1125-5; Hertha formation, locality 102. (p. 104)



Cordell, Missouri Pennsylvanian Bairdiidae



Cordell, Missouri Pennsylvanian Bairdiidae

EXPLANATION OF PLATE 20

All figures ×28

FIGS. *1–3—Bythocypris kellettae* Cordell, n. sp., right, left, and dorsal views, syntype 0-1123-1; Bonner Springs formation, locality 174. (p. 101)

4–5—Bythocypris kellettae Cordell, n. sp., lateral and dorsal views, syntype 0-1123-2; Bonner Springs formation, locality 174. (p. 101)

6–8—Bythocypris kellettae Cordell, n. sp., lateral, posterior, and ventral views of broad form, syntype 0-1123-3; Canville limestone, locality 203. (p. 101)

9—Bythocypris subreniformis Bradfield, dorsal view of young molt, hypotype 0-1122-3; upper shale of Lawrence formation, locality 191. (p. 101)

10–11—Bythocypris subreniformis Bradfield, dorsal and lateral views of narrow form, hypotype 0-1122-4; upper shale of Lawrence formation, locality 191. (p. 101)

12—Bythocypris subreniformis Bradfield, lateral view of broad form, hypotype 0-1122-5; upper shale of Lawrence formation, locality 191. (p. 101)

13–14—Bythocypris kellettae Cordell, n. sp., dorsal and lateral views, syntype 0-1123-4; Canville limestone, locality 203. (p. 101)

15—Bythocypris kellettae Cordell, n. sp., lateral view, syntype 0-1123-5; Canville limestone, locality 203. (p. 101)

16–17—Bythocypris kellettae Cordell, n. sp., lateral and ventral views, syntype 0-1124-1; Canville limestone, locality 203. (p. 101)

18–19—Bythocypris pecki Cordell, n. sp., lateral and dorsal views of narrow form, syntype 0-1124-5; lower shale of Lawrence formation, locality 240. (p. 102)

20–21—Bythocypris pecki Cordell, n. sp., lateral and dorsal views of young molt, syntype 0-1125-1; lower shale of Lawrence formation, locality 240. (p. 102)

22–23—Bythocypris pecki Cordell, n. sp., dorsal and lateral views of broad form, syntype 0-1125-2; lower shale of Lawrence formation, locality 240. (p. 102)

24–26—Waylandella? unicornuta Cordell, n. sp., lateral, ventral, and dorsal views of holotype 0-1127-4; Weston formation, locality 227. (p. 107)

27–28, 36, 39–40, 43–44—Bythocypris pediformis Knight, lateral views of hypotypes 0-1120-2, 0-1120-3, 0-1120-4, 0-1120-5, 0-1121-1, 0-1121-2, and 0-1121-3; Haskell limestone, locality 191. (p. 100)

29–30—Bythocypris pediformis Knight, lateral and dorsal views, hypotype 0-1121-4; Haskell limestone, locality 191. (p. 100)

31–32—Bythocypris pediformis Knight, lateral and dorsal views of young molt, hypotype 0-1121-5; Haskell limestone, locality 191. (p. 100)

33—Bythocypris oblongata Cordell, n. sp., lateral view, syntype 0-1124-3; Muncie Creek shale, locality 175. (p. 102)

34–35—Bythocypris oblongata Cordell, n. sp., lateral and dorsal views, syntype 0-1124-4; Muncie Creek shale, locality 175. (p. 102)

37–38—Bythocypris pediformis Knight, dorsal and lateral views, hypotype 0-1122-1; Haskell limestone, locality 191. (p. 100)

41–42—Bythocypris pediformis Knight, lateral and dorsal views, hypotype 0-1122-2; Haskell limestone, locality 191. (p. 100)

45—Bairdianella sp. 1, lateral view, figured specimen 0-1120-1; Ladore shale, locality 157. (p. 99)

46–47—Bairdianella postcompressa Cordell, n. sp., dorsal and lateral views, holotype 0-1119-5; Vilas formation, locality 235. (p. 98)

48—Macrocypris garrisonensis? Upson, lateral view, figured specimen 0-1126-2; Vilas formation, locality 235. (p. 104)

49–50—Macrocypris garrisonensis? Upson, lateral and ventral views, figured specimen 0-1126-3; Vilas formation, locality 235. (p. 104)

51–53—Microcheilinella sp. 1, lateral, posterior, and dorsal views, figured specimen 0-1127-3; Stark shale, locality 206. (p. 106)

54–56—Microcheilinella parva Cordell, n. sp., dorsal, lateral, and posterior views, holotype 0-1127-2; Weston formation, locality 227. (p. 106)

57—Microcheilinella unispinosa Cooper, lateral view, homoeotype 0-1126-4; Spring Hill limestone, locality 172. (p. 105)

58—Microcheilinella unispinosa Cooper, dorsal view, homoeotype 0-1126-5; Bonner Springs formation, locality 106. (p. 105)

59–61—Microcheilinella compacta Cordell, n. sp., posterior, lateral, and dorsal views, holotype 0-1127-1; Vilas formation, locality 235. (p. 105)

62–64—Acratia recurvata Cordell, n. sp. (anterior hook broken off), ventral, dorsal, and lateral views, syntype 0-1109-3; Vilas formation, locality 235. (p. 81)

65—Acratia recurvata Cordell, n. sp., lateral view of right valve, syntype 0-1109-2; South Bend limestone, locality 236. (p. 81)

66–68—Acratia inornata Cordell, n. sp., lateral, dorsal, and ventral views, holotype 0-1109-1; lower shale of Lawrence formation, locality 240. (p. 80)

The figured specimen is badly weathered, and except for its smaller size, resembles Harlton's holotype, which is also weathered. Knight's figured specimen, judging from his photographs, seems to be both weathered and deformed. Examination of the holotype and of Kellett's homoeotypes from Kansas shows that her specimens are most probably conspecific with the holotype. A few single valves similar to Kellett's specimens were found in the Plattsburg and Oread formations of Missouri, but these are not figured. Although the posterior end is beak-like as in *Bairdia*, the other carapace characters are believed to justify transfer of this species to *Bairdiacypris*.

Occurrence.—Plattsburg formation, Spring Hill limestone member, locality 219, one carapace, two single valves. Oread formation, Snyderville member, locality 188, three single valves; locality 243, three single valves.

Homoeotype.—UM 0-1119-3, Spring Hill limestone, locality 219.

BAIRDIACYPRIS sp. 1
Plate 19, figures 23, 24

Carapace medium in size, elongate, tumid. Shape in lateral view subpolygonal, greatest length ventral, greatest height posterior; dorsal margin high, straight, inclined forward; anterodorsal and posterodorsal slopes moderately steep, straight, longer than usual in the genus; ventral margin long, concave; anterior end narrow, unevenly rounded, terminating below mid-height; posterior end narrow and low, sharply rounded. In dorsal view carapace subfusiform, sides rounded, ends acuminate, the posterior the more so; greatest thickness immediately behind carapace center; valve contact in dorsal view nearly straight. Overlap prominent along ventral margin, particularly at mid-venter, where left valve extends well beyond and over the right; overlap along other margins narrow to obscure. Surface smooth.

Length, 1.22 mm.; height, 0.50 mm.; thickness, 0.42 mm.

When compared with *B. deloi* Bradfield, the specimen described above has a longer posterodorsal slope, and a dorsal margin which instead of being parallel to the carapace length, is inclined forward. *Bairdiacypris haydenbranchensis* (Payne) is somewhat similar to *Bairdiacypris* sp. 1 of this report, but the former has a convex instead of concave ventral margin, and it lacks the anterior inclination of the dorsal margin. Furthermore, the posterodorsal slope of *B. haydenbranchensis* is steep when compared with that of *B.* sp. 1. It is believed that Cooper's figured specimen of *B. haydenbranchensis* (1946, p. 54, pl. 4, figs. 20, 21) is conspecific with *B.* cf. *deloi* Bradfield (1935, p. 93, pl. 7, figs. 9a, b) and that it is possibly conspecific with *B.* sp. 1. The only difference is in dorsal outline, *B.* sp. 1 having a thinner and more definitely subfusiform carapace than do *B.* cf. *deloi* and Cooper's *B. haydenbranchensis*.

Occurrence.—Stranger formation, Vinland member, locality 228, one specimen.

Figured specimen.—UM 0-1119-4, Stranger formation, locality 228.

Genus BAIRDIANELLA Harlton, 1929

Harlton in his paper on the Menard County, Texas ostracode fauna (1929, p. 160) erected the genus *Bairdianella* to include *Bairdia*-like forms which have "no dorsal overlap and a thin, somewhat indistinct ventral overlap, usually only near the middle of the shell." Examination of the holotypes of the two species which he placed in the genus, namely, *B. elegans* Harlton and *B. oblongata* Harlton, indicates that the former species fits the generic characters, but that *B. oblongata* is abraded so as to make its generic affiliations uncertain. This abrasion can be seen along the dorsal margin of the holotype, and the apparent lack of overlap there may be the result of the abrasion, and not an original character. The present author can see little difference between *B. oblongata* and the holotype of *Bairdiacypris glennensis* (Harlton) (1927, p. 210, pl. 33, fig. 10).

BAIRDIANELLA POSTCOMPRESSA
Cordell, n. sp.
Plate 20, figures 46, 47

Carapace small to medium, elongate, thin to moderately tumid. Shape in lateral view subpolygonal, greatest length ventral, greatest height slightly anterior; dorsal margin broadly arched; anterodorsal slope of moderate length and slight convexity; posterodorsal slope long, rather steep and gently

concave in lower part; ventral margin very slightly concave; anterior end unevenly rounded, terminating somewhat below mid-height; posterior beak low, broadly pointed. In dorsal view carapace subfusiform, anterior end compressed, posterior end pointed; greatest thickness posterior; valve contact in dorsal view essentially straight. Overlap obscure and possibly R/L along dorsal margin and upper portion of dorsal slopes, narrow and L/R around ends and along ventral margin; ventral contact slightly sinuous, owing to the somewhat more extensive overlap along the mid-venter. Surface smooth.

Length, 0.70 mm.; height, 0.34 mm.; thickness, 0.24 mm.

B. postcompressa differs from *Bairdianella* sp. 1 of this report in that the former is much larger and lacks the posterior spine on the right valve, which is characteristic of the latter. In addition, the posterior beak is less pointed in *B. postcompressa*. *B.* sp. 1 lacks the well defined posterodorsal slope, and has a broader, higher anterior end and a thinner, more attenuated posterior beak than does *B. postcompressa*.

Occurrence.—?Dennis formation, Winterset member, locality 103, one specimen. Vilas formation, locality 235, five specimens.

Holotype.—UM 0-1119-5, Vilas formation, locality 235.

BAIRDIANELLA sp. 1
Plate 20, figure 45

Carapace small, elongate, relatively thin. Shape in lateral view subovate, greatest length ventral, greatest height anterior; dorsal margin broadly convex, merging evenly with the convex anterodorsal slope; posterodorsal slope sinuous; ventral margin concave; anterior end evenly rounded; posterior beak low, narrow, pointed. In dorsal view carapace subfusiform, sides evenly rounded, ends attenuated, the posterior end the more tapered and pointed; greatest thickness central; valve contact in dorsal view sinuous, with the mid-portion shifted slightly to the left. Overlap narrow and uneven, obscure and possibly R/L dorsally, L/R along other margins; ventral contact markedly curved in ventral view, the overlap being much more extended at mid-venter than elsewhere. A spine present near posteroventral angle of right valve, projecting backward and slightly downward; surface otherwise featureless and smooth.

Length, 0.45 mm.; height, 0.23 mm.; thickness, 0.17 mm.

The species is characterized by presence of the posterior spine. The *Bairdia*-like shape distinguishes *B.* sp. 1 from species of other genera which have posterior spines.

Occurrence.—Ladore formation, locality 157, one specimen. Bonner Springs formation, locality 235, one specimen. Lawrence formation, upper shale member, locality 241 one specimen.

Figured specimen.—UM 0-1120-1, Ladore formation, locality 157.

Genus BYTHOCYPRIS Brady, 1880

Bythocypris is one of the more featureless of the ostracode genera; hence, problems of individual and specific variations have led to differences of opinion regarding classification of specimens. The result has been a large number of species names, many of which are apparently synonyms. Slight differences in carapace contour have been utilized for erection of species, in some cases, apparently without study of abundant suites of specimens. Kellett (1936, p. 781–782) recognized many of the supposed specific differences as individual variations. In her large Mid-Continent collections, most of the variations occurred in every sample where representation was abundant. Accordingly, she placed a considerable number of species in the synonymy of *Bythocypris pediformis* Knight, a species established prior to the erection of most of the American Pennsylvanian species of the genus.

Cooper (1946, p. 55) pursued a course of minute examination of carapace differences within the genus. Furthermore, he transferred most of the species to Kellett's genus, *Coryellites*. He believed the angulation of the posteroventral margin to be a generic feature, and considered this angulation to be an important character of *Coryellites*. However, a study of Kellett's generic description of *Coryellites* (*Coryellina* Kellett, 1935, p. 138; *Coryellites* Kellett, 1936, p. 775) and of her specimens of that genus shows the diagnostic characters to be the posterior ridge or node on the left valve and the well defined depression located immediately anterior. No such features

occur in any of the species which Cooper transferred from *Bythocypris* to *Coryellites*.

The posteroventral angulation or curvature is believed to lack sufficient significance to justify transfer of species of *Bythocypris* to another genus. It even appears that individuals of the same species vary widely in the degree of angulation or of rounding along the posteroventral margin. The author has many samples which contained an abundance of specimens that, according to Cooper, would belong in *Coryellites;* however, nearly all shades of posteroventral angulation are represented in each case.

Cooper further stated that *Bythocypris* is characterized by a concave venter, whereas in *Coryellites* that margin is convex. Nevertheless, a number of species which he included in *Coryellites* are gently concave at mid-venter, a fact which brings into question the taxonomic significance of the ventral margin. Altogether, the evidence shows that the numerous species in question should be retained in *Bythocypris*.

Kellett's judgment (1936) in establishing a large synonymy for *Bythocypris pediformis* to include many species of the genus, fits the evidence found by the author's study of Missouri collections.

Four other species of the genus are described below, three of which are new. Of these species, *B. subreniformis* Bradfield is distinguished from *B. pediformis* by its uniformly smaller size, more broadly convex posteroventral margin, and thicker posterior end. *B. pecki*, n. sp., and *B. kellettae*, n. sp., show brackish-water affinities, and they are distinguished from *B. pediformis* by their more abrupt changes of slope on the lateral surfaces, their greater ventral overlap, their uniformly depressed and narrow or obscure posterodorsal overlap, features not typical of *B. pediformis*, and their more asymmetrical appearance in posterior view. *B. oblongata*, n. sp., besides being more oblong in shape than *B. pediformis*, is more tumid in the posterior portion.

BYTHOCYPRIS PEDIFORMIS Knight
Plate 20, figures 27–32, 36–44

Bythocypris pediformis KNIGHT, 1928, Jour. Paleontology, vol. 2, p. 326, pl. 44, figs. 3a–c; "Upper Fort Scott" limestone (probably Pawnee), Mo. —— WARTHIN, 1930, Oklahoma Geol. Survey Bull. 53, p. 74, pl. 6, figs. 6a, b; Wetumka to Holdenville formations, Okla. —— ?CORYELL & OSORIO, 1932, Am. Mid. Naturalist, vol. 13, p. 35 (no figures); Nowata shale, Okla. —— CORYELL & SAMPLE, 1932, Am. Mid. Naturalist, vol. 13, p. 267, pl. 25, fig. 18; Mineral Wells formation, Texas. —— CORYELL & BOOTH, 1933, Am. Mid. Naturalist, vol. 14, p. 266, pl. 4, fig. 5; Wayland shale, Texas. —— KELLETT, 1935, Jour. Paleontology, vol. 9, p. 135, pl. 16, figs. 8a–f; Stanton to Fort Riley formations (Upper Pennsylvanian to Lower Permian), Kans. —— BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 100, pl. 8, figs. 6a, b; Hoxbar group, just above Westheimer member, Okla. —— JOHNSON, 1936, Nebraska Geol. Survey Paper 11, p. 43, pl. 4, figs. 13–15; Galesburg to Stanton formations, Nebr.

Bythocypris parallela KNIGHT, 1928, Jour Paleontology, vol. 2, p. 327, pl. 44, figs. 2a, b; "Upper Fort Scott" limestone (probably Pawnee), Mo. —— CORYELL & SAMPLE, 1932, Am. Mid. Naturalist, vol. 13, p. 266, pl. 25, fig. 11; East Mountain shale, Texas. —— BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 95, pl. 8, figs. 4a, b; Hoxbar group, shale above Westheimer member, Okla. —— SCOTT & BORGER, 1941, Jour. Paleontology, vol. 15, p. 354, pl. 50, fig. 6; Macoupin formation, Ill.

Bythocypris centralis CORYELL & BILLINGS, 1932, Am. Mid. Naturalist, vol. 13, p. 174, pl. 17, fig. 11; Wayland shale, Texas. —— CORYELL & SAMPLE, 1932, Am. Mid. Naturalist, vol. 13, p. 265, pl. 25, fig. 12; Mineral Wells formation, Texas.

Bythocypris procera CORYELL & BILLINGS, 1932, Am. Mid. Naturalist, vol. 13, p. 174, pl. 17, fig. 12; Wayland shale, Texas.

Bythocypris deesensis BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 95, pl. 7, figs. 12a, b; Deese group, Okla.

Bythocypris hoxbarana BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 101, pl. 8, figs. 8a, b; Hoxbar group, just above Daube limestone, Okla.

Bythocypris simillima BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 96, pl. 7, figs. 10a, b; Deese group, Okla.

Coryellites ovata COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 57, pl. 5, figs. 7, 8; St. David to Newton zones, Ill.

Coryellites mytiliformis COOPER (not *Bythocypris mytiliformis* Bradfield), 1946, Illinois Geol. Survey Bull. 70, p. 57, pl. 5, figs. 1, 2; Newton zone, Ill.

Coryellites parallela COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 58, pl. 5, figs. 15, 16; Liverpool to Jamestown zones, Ill.

Coryellites pediformis COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 58, pl. 5, figs. 19–21; Seville to Shumway zones, Ill.

Coryellites subelliptica COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 59, pl. 5, figs. 29, 30; Liverpool to Shumway zones. Ill.

Coryellites texensis COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 59, pl. 5, figs. 27, 28; Sparland to Shumway zones, Ill.

Coryellites tomlinsonella COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 59, pl. 5, figs. 22, 23; Wiley to Summum zones, Ill.

Carapace small, longer than high, thin to moderately tumid. Shape, in lateral view subovate to arcuate, greatest length ventral, greatest height near valve axis; dorsal margin moderately convex, merging imperceptibly with dorsal slopes; ventral margin gently convex for the most part, slightly concave near middle in some specimens; anterior end evenly rounded; posterior end rounded above, sharply rounded to subangular below along posteroventral margin. In dorsal view carapace subelliptical, sides gently to moderately convex, ends narrowly rounded; greatest thickness slightly posterior; valve contact in dorsal view essentially straight. Overlap variable in amount along margins of a particular specimen; width of overlap variable in position on members of specimen suites; valve contact sharply rounded to angular along posteroventral margin. Surface smooth.

Length, 0.68 mm.; height, 0.43 mm.; thickness, 0.29 mm.

The unusual degree of variation in *B. pediformis* can probably be explained in part by the constant occurrence of both sexes of the species. An additional cause is individual variation, in part original, in part induced by diagenetic changes during consolidation of the enclosing rock. A third source of differences is the occurrence of several growth stages. Finally, it is possible that some specimens belong to generations in which reproduction was by parthenogenesis. It is known that certain modern species of ostracodes have parthenogenetic stages, and it is conceivable that individuals produced in this manner might show unusual variations.

Occurrence.—Top of Pleasanton shale to Heumader member of Oread formation; abundant in many stratigraphic units.

Hypotypes.—UM 0-1120-2, 0-1120-3, 0-1120-4, 0-1120-5, 0-1121-1, 0-1121-2, 0-1121-3, 0-1121-4, 0-1121-5, 0-1122-1, 0-1122-2, Haskell limestone, locality 191.

BYTHOCYPRIS SUBRENIFORMIS Bradfield
Plate 20, figures 9–12

Bythocypris subreniformis BRADFIELD, 1935, Bull. Am. Paleontology, vol. 22, p. 100, pl. 8, figs. 7a, b; Hoxbar group, Union Dairy limestone, Okla.

Bythocypris quadrata COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 55, pl. 4, figs. 34, 35; "Centralia" zone, Ill.

Length, 0.54 mm.; height, 0.27 mm.; thickness, 0.26 mm.

Examination of the holotype of *B. quadrata* Cooper (1946, p. 55, pl. 4, figs. 34, 35) shows very obscure posterior swellings and an overall appearance almost identical with that of the thin, probably male specimens of the species in the Missouri collections. The anterior end is higher and the posteroventral margin more sharply rounded in Cooper's specimen, when compared with the typical Missouri carapace of the species; however, some of the latter are nearly identical with *B. quadrata*.

This very small species of *Bythocypris* differs from similarly rounded species of the genus in having a more broadly rounded posteroventral margin. Other diagnostic features are the low anterior end and the full posterior portion, as seen in dorsal view. Bradfield's holotype is slightly crushed, judging from his figures, but the diagnostic characters are apparent.

Occurrence.—Ladore formation to top of Oread formation; most abundantly represented in Weston and Iatan formations.

Hypotypes.—UM 0-1122-3, 0-1122-4 and 0-1122-5, upper shale of Lawrence formation, locality 191.

BYTHOCYPRIS KELLETTAE Cordell, n. sp.
Plate 20, figures 1–8, 13–17

Carapace small, elongate, with variable form ratio, thin to somewhat tumid. Shape in lateral view subovate, greatest length slightly ventral, greatest height medial or somewhat posterior; dorsal margin slightly to moderately convex; ventral margin straight to gently convex; anterior end evenly rounded, posterior end unevenly convex, the lower portion more narrowly rounded than the upper. In dorsal view carapace narrowly subovate to subfusiform, sides gently to moderately and unevenly convex, anterior end acuminate, posterior end broadly pointed; slight angulation of outline frequently present on posteroventral margin; greatest thickness posterior; valve contact in dorsal view gently sinuous, the line bending slightly toward the right valve in posterior portion; contact somewhat depressed for a short distance behind midvalve. Overlap most conspicuous along ventral margin, very narrow or obscure along posterodorsal slope. Carapace marked by

slight longitudinal posterior change of slope on each valve; posterior slope change of left valve more obscure than on the right, located very close to margin, ending at the base in a very low generalized swelling; obscure ventrally-situated slope changes present on each valve; slope changes on right valve farther from margins than those on the left. Carapace surface smooth.

Length, 0.59 mm.; height, 0.34 mm.; thickness, 0.28 mm.

This new species is named in honor of Mrs. Betty Kellett Nadeau, whose general and detailed suggestions helped make this report possible.

Occurrence.—Ladore formation to Heumader member of Oread formation, common to abundant in a large number of samples.

Syntypes.—UM 0-1123-1 and 0-1123-2, Bonner Springs formation, locality 174; 0-1123-3, 0-1123-4, 0-1123-5, and 0-1124-1, Canville limestone, locality 203.

BYTHOCYPRIS OBLONGATA Cordell, n. sp.
Plate 20, figures 33–35

Carapace small, elongate, thin or average in thickness. Shape in lateral view subrectangular to subpentagonal, greatest length typically medial, greatest height anterior; dorsal margin straight or very broadly curved, gently inclined in the posterior direction; posterodorsal margin much more narrowly rounded than the anterodorsal; anterior end evenly rounded, posterior margin essentially straight, nearly parallel to carapace height; posteroventral margin sharply rounded to subangular. In dorsal view carapace elongate-subelliptical, sides nearly straight; anterior end slightly tapered, posterior end blunt; greatest thickness posterior, in the posterior third in most specimens; valve contact in dorsal view straight. Overlap very slight along dorsal margin, moderate and even along other margins; valve contact in lateral view sharply curved along posterodorsal margin, subangular along posteroventral margin. Surface smooth.

Length, 0.63 mm.; height, 0.35 mm.; thickness, 0.28 mm.

The combination of characters which distinguishes *B. oblongata* from other species of *Bythocypris* are: (1) The sharply convex posterodorsal margin; (2) the approximately right-angled posteroventral margin; and (3) the full posterior portion of the carapace as seen in dorsal view.

Occurrence.—? Pleasanton, top, locality 165, one specimen. Iola formation, Muncie Creek member, locality 175, abundant. Wyandotte formation, Quindaro member, locality 167, one specimen; Farley member, locality 106, two specimens. Bonner Springs formation, locality 221, four specimens. Stanton formation, Eudora member, locality 176, four specimens. Lawrence formation, lower shale member, locality 228, one specimen.

Syntypes.—UM 0-1124-3 and 0-1124-4, Muncie Creek shale, locality 175.

BYTHOCYPRIS PECKI Cordell, n. sp.
Plate 20, figures 18–23

Carapace small, elongate, moderately tumid. Shape in lateral view subovate, greatest length well below midheight, greatest height medial to slightly posterior; dorsal margin gently convex, and very broadly arched; ventral margin gently convex; anterior end evenly rounded; posterior end truncate above, narrowly rounded below, where it terminates well below midheight. In dorsal view carapace narrowly subcuneate to subfusiform, sides tapering forward in gentle convexity; anterior end attenuated, posterior end short, narrowly rounded; greatest thickness posterior; valve contact in dorsal view gently sinuous, very slightly incised for a short distance behind middorsum. Overlap uneven, obscure or only apparent along posterodorsal slope, broad, but in part apparent around posterior end and along venter, even along anterior end. In posterior view carapace asymmetrical, the lower portion of left valve much more sharply convex than that of the right valve; valve contact in posterior view oblique, bending toward the left in lower portion. Lateral surfaces of both valves marked by abrupt changes in slope in ventral and posterior portions, giving rise to a slight, ventral, transverse slope change in the valve surface, and a similar longitudinal slope change in the posterior surface.

Length, 0.63 mm.; height, 0.38 mm.; thickness, 0.27 mm.

Neanic carapaces differ from adults in that the former possess more accentuated ventral and posterior slope changes of the valve surface, which are more distant from the posterior end than in the latter. Further-

more, the posteroventral margin of immature forms is more acutely angular than in the adults. Some mature specimens are much thinner than others, particularly in the posterior portion; these are presumably the males of the species. *B. pecki* is most similar to *B. kellettae*, n. sp., but the former is larger than the latter, and has better defined slope changes in ventral and posterior portions of the lateral surface, particularly on the left valve.

The new species is named in honor of Professor Raymond E. Peck, of the University of Missouri, whose advice has been of much assistance in the author's investigation of Pennsylvanian ostracodes.

Occurrence.—Galesburg formation, locality 203, common. Cherryvale formation, Quivira member, locality 208, abundant. Stanton formation, Eudora member, locality 234, rare. Lawrence formation, lower shale member, locality 240, abundant.

Syntypes.—UM 0-1124-5, 0-1125-1, and 0-1125-2, lower shale of Lawrence formation, locality 240.

Genus FABALICYPRIS Cooper, 1946

The three new species of *Fabalicypris* described below fit Cooper's generic description except for two differences in the lateral contour. Cooper stated (1946, p. 59) that the ventral margin in the genus is convex, whereas the midventral portion is concave in *F. regularis* Cooper and *F. wetumkaensis* Cooper, as well as in some of the Missouri specimens of the genus. He also described the posterior end to be slightly more acuminate than the anterior end, whereas in *F. pulcher*, n. sp., the reverse is true. These deviants are believed not to be sufficiently different to justify their generic separation from *Fabalicypris*. The abrupt decrease in overlap in front of mid-venter is a generic character, but it is variable, as the abruptness was apparently increased or decreased in individual specimens during or after fossilization. Some specimens of *Bairdia hoxbarensis* Harlton show an offset in the ventral overlap nearly as abrupt as in some specimens of *Fabalicypris*. However, *Fabalicypris* is more tumid posteriorly and it has a less distinguishable posterodorsal slope than do any of the variants within *B. hoxbarensis*. *Bairdia altifrons* Knight (1928) and closely related species have the posterior fullness of *Fabalicypris*, but they also are characterized by a definite posterior beak and a highly irregular overlap which are not found in species of *Fabalicypris*. With the restriction of the genus *Bairdiacypris* to those forms with angular shape in lateral view, there is little difficulty in distinguishing that genus from *Fabalicypris*.

Fabalicypris is rather common in many of the author's samples from the Cherokee and Marmaton groups of Missouri, and the genus is found as high as the base of the Hushpuckney member of the Swope. It seems significant that the genus is not represented in the many Missouri samples from beds higher than the Hushpuckney.

FABALICYPRIS PULCHER Cordell, n. sp.
Plate 19, figures 32, 35–36, 39

Carapace medium to large, elongate, moderately tumid. Shape in lateral view narrowly subelliptical, greatest length dorsal, greatest height posterior; dorsal margin broadly and gently convex, curving downward more steeply posteriorly than anteriorly; ventral margin straight to very slightly concave medially, whence the margin curves upward rather abruptly toward anterior extremity, in even convexity toward posterior end; anterior end more attenuated and narrower than usual in the genus, terminating well above midheight; posterior end evenly rounded, symmetrical, terminating about midheight. In dorsal view carapace narrowly subelliptical, sides long, very gently rounded; posterior end much less attenuated than the anterior; greatest thickness posterior; valve contact in dorsal view nearly straight, bending slightly toward the right near the ends, and at terminations swinging sharply toward the left. Overlap narrow and even along dorsal margin, absent or very narrow around ends, prominent along ventral margin; offset of ventral contact gradual. Surface smooth or faintly granulose.

Length, 1.22 mm.; height, 0.54 mm.; thickness, 0.47 mm.

Three specimens are much smaller than the rest, and appear to be immature molts. Carapace outline and overlap are similar in the small and large specimens, but the former have narrower carapaces. The species is most similar to *F. wetumkaensis* Cooper and *F. regularis* Cooper (1946, pp. 60–61, pl. 6,

figs, 1–3, 12–19). *F. wetumkaensis* has a much wider dorsal overlap than does *F. pulcher*, and the ventral margin of the former appears to have greater tendency toward concavity. There is also considerable difference in size, *F. wetumkaensis* being much the larger. *F. regularis* has the narrow dorsal overlap of *F. pulcher*, but its midventral margin is definitely concave, and its ventral overlap is much less pronounced than in *F. pulcher*. The abruptness of offset in the ventral contact is a variable character, depending apparently on slight changes of contour during fossilization, as well as on individual variations.

Occurrence.—Pleasanton shale, top, locality 60, five specimens. Swope formation, Hushpuckney member, locality 65, ten specimens.

Holotype.—UM 0-1125-3, Hushpuckney shale, locality 65. *Paratype.*—0-1125-4, Hushpuckney shale, locality 65.

FABALICYPRIS SUBELLIPTICA
Cordell, n. sp.
Plate 19, figures 37, 38

Carapace below average for the genus in size, elongate, tumid. Shape in lateral view subelliptical, greatest length medial, greatest height posterior; dorsal margin evenly and broadly convex, merging imperceptibly with the end margins; ventral margin gently convex, merging evenly with the very slightly upswung end slopes. In dorsal view carapace subelliptical, anterior end tapered more than the posterior; greatest thickness in posterior third; valve contact in dorsal view straight except near ends where it curves to the left. Overlap narrow and even along dorsal margin, broader along the ventral margin, attaining maximum width at about mid-venter; overlap around ends narrow and variable with slight distortion of carapace; valve contact in ventral view offset rather abruptly in posterior half. Surface smooth.

Length, 1.14 mm.; height, 0.51 mm.; thickness, 0.44 mm.

This species is quite close to *F. pulcher*, n. sp., and when larger suites of specimens are obtained and studied, the two species may possibly be grouped more judiciously within a single species. With the available specimens, *F. subelliptica* appears to have a slightly more even outline in lateral view than does *F. pulcher*, with less tendency toward definition of posterodorsal and anteroventral slopes. The ends in *F. subelliptica* are slightly broader, and the anterior end is lower than in *F. pulcher*.

Occurrence.—Hertha formation, locality 102, four specimens; Ladore formation, locality 165, two specimens.

Holotype.—UM 0-1125-5, Hertha formation, locality 102.

FABALICYPRIS sp. 1
Plate 19, figures 31, 33, 34

Carapace medium to large, elongate, tumid. Shape in lateral view subelliptical, greatest length dorsal, greatest height medial; dorsal margin broadly convex, curving downward more sharply toward posterior extremity than toward anterior; ventral margin approximately straight medially, swinging upward with equal sharpness toward anterior and posterior extremities; anterior end rounded, terminating above midheight; posterior end unevenly rounded, more narrowly curved above than below, ending above midheight. In dorsal view carapace narrowly subelliptical, sides gently and evenly convex, ends blunt, the anterior end the more acuminate; greatest thickness in posterior third; valve contact in dorsal view nearly straight except near the ends where it curves rather abruptly toward the left. Overlap narrow and even along dorsal margin, extending unchanged well down toward posterior extremity; ventral overlap prominent and moderately offset medially, narrow along upswept margins. Surface smooth.

Length, 1.00 mm.; height, 0.59 mm.; thickness, 0.41 mm.

Only one specimen is represented, and it appears to be slightly distorted. However, it has the characters of *Fabalicypris*, and even in its original state the ends must have been higher than on any previously described species of the genus.

Occurrence.—Top of Pleasanton shale, locality 60.

Figured specimen.—UM 0-1126-1, top of Pleasanton shale, locality 60.

Genus MACROCYPRIS Brady, 1867
MACROCYPRIS GARRISONENSIS? Upson
Plate 20, figures 48–50

Macrocypris garrisonensis UPSON, 1933, Nebraska Geol. Survey Bull. 8, p. 25, pl. 2, figs.

14a, b; upper Garrison formation, Kans.—KELLETT, 1935, Jour. Paleontology, vol. 9, p. 139, pl. 16, figs. 10d, e; Middle Pennsylvanian to Wreford (Lower Permian), Kans.

Carapace medium in size, elongate, of moderate tumidity. Shape in lateral view narrowly arcuate, greatest length near ventral margin, greatest height medial; dorsal margin broadly arched; anterodorsal slope relatively long, gently convex; ventral margin nearly straight, rising slightly toward posterior end; anterior end relatively narrow, terminating well below midheight; posterior beak attenuated, narrowly pointed, directed posteriorly, and generally slightly downward. Carapace in dorsal view subfusiform, sides long, gently rounded, ends attenuated, the anterior end compressed, posterior end pointed; greatest thickness central or slightly posterior; valve contact in dorsal view gently sinuous with the reversal of overlap. Overlap uneven, narrow but extended, L/R along most of dorsal margin, R/L along other margins; ventral contact in ventral view sinuous, as the right valve extends farther over the left along mid-venter than elsewhere along ventral margin. Surface granulose or smooth.

Length, 0.94 mm.; height, 0.38 mm.; thickness, 0.30 mm.

According to Kellett (1935, p. 139) the only difference between *M. garrisonensis* and *M. menardensis* Harlton (1929, p. 161, pl. 4, figs. 7a, b) is relative size, the former being considerably smaller than the latter. The adult Missouri specimens are slightly larger than *M. garrisonensis* and slightly smaller than *M. menardensis*. Both species are possibly represented in the Missouri samples. The figured specimens, which are comparable in size to *M. garrisonensis*, have the points of the posterior beaks broken off. Isolated specimens in several samples are about midway in size between the two species.

Occurrence.—Ladore formation, locality 59, one specimen. Cherryvale formation, Westerville member, locality 196, one specimen. Bonner Springs formation, locality 235, three specimens. Vilas formation, locality 235, 11 specimens, mostly single valves. Stanton formation, South Bend member, locality 236, four carapaces, 12 single valves; Stoner member, locality 225, one specimen.

Figured specimen.—UM 0-1126-2 and 0-1126-3, Vilas formation, locality 235.

Genus MICROCHEILINELLA Geis, 1933

MICROCHEILINELLA UNISPINOSA Cooper

Plate 20, figures 57, 58

Microcheilinella unispinosa COOPER, 1946, Illinois Geol. Survey Bull. 70, p. 63, pl. 6, figs. 31–33; Little Vermilion zone, Ill.

Length, 0.45 mm.; height, 0.23 mm.; thickness, 0.23 mm.

The presence of a single prominent posterior spine distinguishes *M. unispinosa* from most species of the genus. *M. bicornuta* Cooper (1946, p. 62, pl. 6, figs. 34–37) and *M. parva*, n. sp., have two posterior spines. Other Pennsylvanian species of the genus, with the exception of *M. minuta* Cooper (1946, p. 62, pl. 6, figs. 47–49), lack posterior spines. *M. minuta* has an elliptical shape in lateral view, instead of the quadrate shape of *M. unispinosa*. Cooper's figures of the latter show greater apparent dorsal overlap, and a stouter posterior spine than do most Missouri specimens, but these characters show individual variations. Cooper's holotype is also somewhat larger than the Missouri specimens. When more and larger suites of *Microcheilinella* are available from all parts of the Pennsylvanian section, such differences may assume stratigraphic importance, and justify the erection of additional species.

Occurrence.—Muncie Creek member of Iola formation to upper shale of Lawrence formation. The species is represented sparingly in most occurrences but it is common in the Weston and Iatan formations, and apparently reached its maximum representation while those formations were being deposited.

Homoeotypes.—UM 0-1126-4, Spring Hill limestone, locality 172; 0-1126-5, Bonner Springs formation, locality 106.

MICROCHEILINELLA COMPACTA

Cordell, n. sp.

Plate 20, figures 59–61

Microcheilinella inflata COOPER, 1946 (not Kellett), Illinois Geol. Survey Bull. 70, p. 63, pl. 6, figs. 20, 21; Bogota zone, Ill.

Carapace small, with forward swing, longer than high, tumid. Shape in lateral view subelliptical, greatest length medial, greatest height anterior; dorsal and ventral

margins short, gently convex; ends rounded, anterior end broad, merging smoothly with anterdorsal margin; posterior end narrow, meeting dorsal margin in narrow curvature. In dorsal view carapace subovate, full; sides rather sharply rounded, ends blunt, the anterior end the more tapered; hinge line in dorsal view slightly convex toward the left, broadly and deeply incised; greatest thickness posterior. In posterior view carapace moderately asymmetrical, valve contact broadly sinuous. True overlap around free margins moderate; an additional apparent overlap present around the entire margin, widest around ventral margin. Valve surface faintly granulose.

Length, 0.51 mm.; height, 0.33 mm.; thickness, 0.32 mm.

M. inflata Kellett (1935, p. 140, pl. 16, figs. 12a-e) is close to the new species, but the former has a narrower, more tapered posterior end in lateral view, and a more sharply convex dorsal margin. The only other closely related species appears to be *M. spinosa* Geis (1932), from the Mississippian. *M. compacta* when compared with *M. spinosa* has a convex rather than straight ventral margin, and a subcuneate rather than subovate profile in dorsal view. Also, *M. compacta* has no posterior spine, in contrast to the Mississippian species.

Occurrence.—Ladore formation to base of Kanwaka shale. The species is the most abundant representative of the genus among the Missouri samples. It was found in only a few samples in the Kansas City group, but occurred more abundantly in samples from higher beds.

Holotype.—UM 0-1127-1, Vilas formation, locality 235.

Microcheilinella parva
Cordell, n. sp.
Plate 20, figures 54–56

Carapace small, elongate, tumid. Shape in lateral view subquadrate, greatest length medial or ventral, greatest height anterior; dorsal margin straight, sloping moderately backward; ventral margin broadly convex; anterior end evenly rounded; posterior end more narrowly rounded than the anterior. In dorsal view carapace broadly subcuneate, full, ends blunt; dorsal contact sinuous, slightly incised; greatest thickness posterior. In posterior view carapace broad, subovate; valve contact in posterior view sharply sinuous, the lower portion strongly convex to the left. Overlap moderate, more apparent than true dorsally and posteriorly, of moderate width along other margins. Posterior end ornamented by two prominent, ventrally located spines, one on each valve, which project backward in relatively close proximity; valve surface otherwise unornamented and smooth.

Length, 0.53 mm.; height, 0.27 mm.; thickness, 0.20 mm.

Appreciable individual differences exist in the degree of slope of the straight dorsal margin, and in the relative broadness of the posterior end. These variations are not thought to be of specific importance.

The species most closely related to *M. parva* is apparently *M. bicornuta* Cooper (1946, p. 62, pl. 6, figs. 34–37), from the "Centralia" zone of Illinois, which is somewhat lower in the section than the Missouri occurrences of *M. parva*. The holotype of *M. bicornuta* is larger and thicker than the new species, and the former lacks the definite backward tilt of the dorsal margin found in the latter. A specimen found in the Stark shale of Missouri approximates the size and general characters of *M. bicornuta* more closely than do specimens of the new species. However, this specimen is much thinner than Cooper's holotype of *M. bicornuta*.

Occurrence.—Wyandotte formation, Argentine member, locality 193, one specimen. Vilas formation, locality 235, one specimen. Stanton formation, Stoner member, locality 210, three specimens. Weston formation, locality 227, three specimens. Oread formation, Snyderville member, locality 243, one specimen.

Holotype.—UM 0-1127-2, Weston formation, locality 227.

Microcheilinella sp. 1
Plate 20, figures 51–53

Carapace large for the genus, elongate, tumid. Shape in lateral view elongate-elliptical, greatest length ventral, greatest height medial; dorsal margin long, essentially straight, passing abruptly into short antero- and posterodorsal slopes; ventral margin long, gently concave; anterior end more narrowly rounded below than above, terminating well below midheight; posterior

end evenly rounded, bounded below by a short but prominent posteroventral slope. In dorsal view carapace elongate-subpolygonal, full, sides nearly flat, converging slightly toward anterior; ends blunt, the posterior end the broader; greatest thickness ventral and in posterior third; valve contact in dorsal view nearly straight, slightly depressed. Overlap even and partially apparent rather than true along dorsal and ventral margins, prominent and true around anterior end. In posterior view carapace subtriangular, left valve swollen ventrally and extending much lower than the right; valve contact in posterior view less curved than usual in the genus. Surface smooth.

Length, 0.84 mm.; height, 0.48 mm.; thickness, 0.47 mm.

The specimens described above are most similar to *M. quadrata* Cooper (1946, p. 63, pl. 6, figs. 41–44), but there are several differences. The anterior end of Cooper's species is higher and the carapace is more elongate than in *M.* sp. 1. In posterior view *M. quadrata* shows a marked curvature of valve contact, with the axially convex right valve fitting into an opposing concavity in the left valve. In contrast, *M.* sp. 1 has a nearly straight posterior contact. Furthermore, the left valve of the Illinois species does not extend as far below the right valve as in the specimens described above.

Occurrence.—Stark member of Dennis formation, locality 206, two carapaces, two single valves.

Figured specimen.—UM 0-1127-3, Stark shale, locality 206.

Genus WAYLANDELLA
Coryell & Billings, 1932

One possible species of *Waylandella* is represented in the Missourian and lower Virgilian collections from Missouri. Previously described species of the genus have either one or two spines or a ridge near the posterior end of each valve, but the new species, *W.? unicornuta*, has only one spine, located near the posteroventral margin of the right valve. This species also has less dorsal overlap than other species of the genus, and its dorsal contact is very slightly and narrowly depressed, a feature not previously ascribed to *Waylandella*. The numerous species of *Waylandella* found by Cooper (1946, pp. 64–65) in Illinois strata older than those of the present report are completely absent from the Missourian and lower Virgilian of Missouri.

WAYLANDELLA? UNICORNUTA
Cordell, n. sp.
Plate 20, figures 24–26

Carapace small, elongate, tumid. Shape in lateral view subelliptical to subpolygonal, greatest length ventral, greatest height medial or posterior; dorsal and ventral margins very broadly convex, the former merging with long antero- and posterodorsal slopes, the latter long, and without prominent upsweep of margin; anterior end narrow, terminating below midheight; posterior end narrower than the anterior, terminating at a lower elevation. In dorsal view carapace broadly subfusiform to narrowly subovate, sides broadly curved, ends full, the anterior the more attenuated; greatest thickness posterior; valve contact in dorsal view gently sinuous, with a straight, narrow, shallow incision in its mid-portion, which is very slightly offset to the left; end portions of dorsal contact formed by true overlap. Overlap uneven, absent dorsally, of moderate width around ends, prominent along venter, where in ventral view the contact is sinuous, a character resulting from a more extended overlap in the medial portion. Posteroventral portion of lateral surface of the right valve ornamented by a short, small spine. located near posteroventral margin; valve surface otherwise featureless and smooth.

Length, 0.63 mm.; height, 0.34 mm.; thickness, 0.36 mm.

W.? unicornuta differs from other species of the genus in its shape in lateral view. No other species of *Waylandella* has the long antero- and posterodorsal slopes, and the narrow, attenuated ends which are present in the Missouri species. Posterior spines are characteristically present on both valves in species of *Waylandella*, but in *W.? unicornuta* only the right valve is ornamented.

Occurrence.—Iola formation, Muncie Creek member, locality 196, two specimens; locality 218, two specimens. Lane formation, locality 167, one specimen. Weston formation, locality 227, seven specimens; locality 237, two specimens. Iatan formation, locality 233, three specimens; locality 238, three specimens. Lawrence formation, upper shale member, locality 191, one specimen. Oread

formation, Snyderville member, locality 243, one specimen.

Holotype.—UM 0-1127-4, Weston formation, locality 227.

LIST OF LOCALITIES

57. NW¼, SE¼, sec. 33, T. 65 N., R. 24 W.; 0.6 mile SW of Princeton, Mercer County, Missouri; beneath bridge across old cut of the Chicago, Rock Island, and Pacific Railroad. Ladore shale, top; shale parting 8 feet above base of Bethany Falls limestone.
59. NE¼, SE¼, sec. 8, T. 64 N., R. 24 W.; 2.6 miles SW of Princeton, Mercer County, Missouri; road cuts along crooked stretch of gravel road on W bluff of Weldon River valley. Ladore shale, top; shale parting 16 feet above base of Winterset limestone.
60. NE¼, SE¼, sec. 33, T. 65 N., R. 24 W.; 0.3 mile SW of Princeton, Mercer County, Missouri; SE and S bluffs of Weldon River valley, in a gully immediately southeast of old bed of Chicago, Rock Island, and Pacific Railroad. Pleasanton shale, top.
65. NW¼, SW¼, sec. 13, and SW¼, NW¼, sec. 13, T. 61 N., R. 25 W.; 1.8 miles W of Trenton, Grundy County, Missouri; near head of ravine, both N and S of State Highway No. 6, 350 feet W of its junction with County Highway W. Collections 7 feet above base of Ladore shale; Hushpuckney shale, base; 2 feet, four inches above base of Bethany Falls limestone.
66. SE¼, SE¼, NE¼, sec. 21, T. 60 N., R. 25 W.; 2.2 miles W of Hickory, Grundy County, Missouri; Chicago, Rock Island, and Pacific Railroad cut, along S bluff of Gees Creek. Shale parting 2 feet, 6 inches above base of Sniabar limestone; Ladore shale, base.
102. NE¼, NE¼, sec. 21, T. 57 N., R. 25 W.; 0.3 mile SE of Mooresville, Livingston County, Missouri; ditch along County Highway D, and gully and creek to the E; all exposures 0.1 to 0.2 mile S of State Highway No. 36. Pleasanton shale, top; shale parting 3 feet above base of Sniabar limestone member of Hertha.
103. W½, SE¼, sec. 17, T. 59 N., R. 27 W.; NE edge of Gallatin, Daviess County, Missouri; road cut on State Highway No. 6, and gully and ravine to the N. Shale parting 3 feet above base of Winterset limestone; Fontana shale, top; Wea shale, top.
104. SE¼, NE¼, sec. 17, T. 59 N., R. 27 W.; 0.3 mile NE of Gallatin, Daviess County, Missouri; quarry and cut along Chicago, Rock Island, and Pacific Railroad, N of State Highway No. 6, along W bluff of Grand River valley. Stark shale, top.
106. SE¼, sec. 29, T. 59 N., R. 29 W.; 2.2 miles NW of Winston, Daviess County, Missouri; outcrops along Smith Branch, W of bridge and W of N-S road. Collections from 2 feet, 6 inches below top of Farley limestone to top of Eudora shale.
108. SW¼, SW¼, sec. 12, and NW¼, NW¼, sec. 13, T. 47 N., R. 29 W.; 3 miles NW of Elm, Johnson County, Missouri; quarry, hill, and ravine outcrops south of E-W road. Ladore shale, base; Hushpuckney shale, top.
152. SE¼, SE¼, sec. 26, T. 49 N., R. 28 W.; 0.6 mile N of Odessa, Lafayette County, Missouri; quarry, 0.2 mile N of State Highway No. 131. Hushpuckney shale, top; shale parting 5 feet above base of Bethany Falls limestone.
156. Near center of S½, sec. 7, T. 46 N., R. 30 W.; 0.4 mile W of N edge of Pleasant Hill, Cass County, Missouri; ditch exposures along N-S road. Ladore shale, base.
157. About midway N-S in sec. 23, 0.2 mile W of E boundary of the section, T. 46 N., R. 31 W.; 1.5 miles W of Pleasant Hill, Cass County, Missouri; exposure in creek bed, short distance N of gravel road. Ladore shale, top.
165. S½, SW¼, sec. 6, T. 52 N., R. 29 W.; 0.2 to 0.6 mile E of Excelsior Springs, in Ray County, Missouri; road cuts, quarry, and gully section, extending from East Fork Creek bridge eastward along and near State Highway No. 10 to about center of sec. 6. Pleasanton shale, top, to 1 foot, 4 inches above base of Drum formation.
167. SE¼, SW¼, sec. 25, and NE¼, NW¼, sec. 36, T. 54 N., R. 31 W.; 0.3 mile E of Holt, near Clay-Clinton County line; ravine exposures, N and S of gravel road. Collections from 4 feet, 3 inches below top of Quivira shale to top of Quindaro shale.
168. Short distance S of center of sec. 29, T. 54 N., R. 30 W.; 2.2 miles E of Holt, Clinton County, Missouri; ditch exposures, ravine, and quarry S of gravel road. Collections 6 feet below top of Island Creek shale; top of Bonner Springs shale; middle of Hickory Creek shale.
169. S½, sec. 13, T. 56 N., R. 30 W.; 4.8 miles S of Cameron, Clinton County, Missouri; near NW corner of Wallace State Park; road cuts along State Highway No. 121, on long hill from E termination of highway to Deer Creek bridge; also creek cut, 400 feet N of Deer Creek bridge. Collections from 3 feet below top of Chanute shale to top of Bonner Springs shale.
170. Near the center of S½, sec. 14, T. 56 N., R. 30 W.; 4.8 miles S of Cameron, Clinton County, Missouri; quarry just N of State Highway No. 121, and creek cut. Shale parting 1 foot below top of Stoner limestone.
172. NE¼, sec. 2, T. 58 N., R. 31 W.; 1 mile SE of Maysville, DeKalb County, Missouri; E bluff of West Fork of Lost Creek, about 0.2 mile E of bend between E-W and N-S stretches of road. Hickory Creek shale, top; base and top of a 1 foot, 4 inch shale break, 3 feet, 8 inches above base of Spring Hill limestone.
173. NE¼, NE¼, sec. 35, T. 59 N., R. 30 W.; 1.8 miles SE of Weatherby, DeKalb County, Missouri; road cuts along hill, N of Oak Ridge School. Island Creek shale, top; Hickory Creek shale, middle and top.

174. SE¼, SE¼, sec. 28, and along boundary between secs. 28 and 33, T. 61 N., R. 30 W.; 4 miles E of Berlin, Gentry County, Missouri; road cuts on E-W road, W of bridge; also, ravine outcrops between bridge on E-W road and bridge on N-S road. Bonner Springs shale, base, to base of Hickory Creek shale.
175. Boundary between secs. 35 and 36, a short distance S of midway along section boundary, T. 62 N., R. 31 W.; 5.3 miles N of Berlin, Gentry County, Missouri; E bank of Grand River, immediately N of bridge. Muncie Creek shale, base and top; shale parting, 1 foot, 3 inches above base of Raytown limestone.
176. S½, SE¼, sec. 35, T. 62 N., R. 31 W.; 5 miles N of Berlin, Gentry County, Missouri; road cut along E side of County Highway A. Eudora shale, base and top.
177. About center, S½, SE¼, sec. 9, T. 63 N., R. 28 W.; W edge of Bethany, Harrison County, Missouri; S part of large quarry, about 1000 feet S of gravel road, immediately E of East Fork of Big Creek. Collections 4 feet above base of Fontana shale; two shale partings in Block limestone.
178. Near NE cor., sec. 3, T. 62 N., R. 28 W.; 3.3 miles S of Bethany, Harrison County, Missouri; road cut, W side of road, about 200 feet SE of Polecat Creek bridge. Collections from 6 feet below top of Wea shale to 1 foot, 3 inches above base of Westerville limestone.
188. NW¼, sec. 36, T. 59 N., R. 36 W.; N part of Amazonia, Andrew County, Missouri; road cut, E side of County Highway K. Snyderville shale, top; Heebner shale, top.
189. NE¼, SW¼, sec. 36, T. 59 N., R. 36 W.; W edge of Amazonia, Andrew County, Missouri; Missouri River valley bluff, just NE of Chicago, Burlington and Quincy Railroad. Upper Lawrence shale, base.
190. About 0.1 mile south of center, sec. 30, T. 58 N., R. 35 W.; 1 mile W of Industrial City (Urban Compact), suburb of St. Joseph, Buchanan County, Missouri; Missouri River valley bluff, E of Chicago, Burlington, and Quincy tracks. Upper Lawrence, base, to top of Heumader shale.
191. Near boundary between secs. 30 and 31, about one-fourth of the distance from E to W along the section boundary, T. 57 N., R. 35 W.; in South St. Joseph, Buchanan County, Missouri; ditch at corner of State Highway No. 59 and Russel St., and bluff exposures to the NE. Shale parting 1 foot, 9 inches below top of Haskell limestone; lower Lawrence shale, base and top; upper Lawrence shale, base.
192. NW¼, NE¼, sec. 12, T. 55 N., R. 37 W.; 2.3 miles NE of Rushville, Buchanan County, Missouri; S side of creek, S of E-W road. Lower Lawrence shale, top.
193. Near W boundary of sec. 23, T. 53 N., R. 33 W.; W edge of Smithville, Clay County, Missouri; road cut and bluff immediately E of State Highway No. 169, and just S of Little Platte River bridge. Collections from middle of Raytown limestone to base of Island Creek shale.
194. On boundary between secs. 22 and 23, about 0.2 the distance from S to N along section boundary, T. 53 N., R. 33 W.; SW edge of Smithville, Clay County, Missouri; W side of State Highway No. 169, near top of first hill south of Little Platte River bridge. Tops of Bonner Springs shale, Hickory Creek shale, Vilas shale, and Eudora shale.
195. Steep hill slope W of Southwest Blvd., about in line with 27th and 28th streets, near W edge of Kansas City, Jackson County, Missouri. Fontana shale, base; Quivira shale, base and top.
196. Bluff exposures, near W end of 12th St., at end of bridge across railroad tracks, near NW edge of Kansas City, Jackson County, Missouri. Collections from 6 feet, 6 inches below top of Westerville limestone to base of Lane shale.
198. Midway along boundary between secs. 11 and 12, T. 48 N., R. 33 W.; near SE edge of Kansas City, Jackson County, Missouri; bluff N of small lake, immediately N of County Highway No. 5S, a few hundred feet E of Blue River, in Swope Park. Pleasanton shale, top; Ladore shale, top.
203. SW¼, NW¼, sec. 23, T. 58 N., R. 23 W.; 4.5 miles NW of Wheeling, Livingston County, Missouri; quarry section, 300 feet E of N-S road, S side of valley; Galesburg shale, base, to 23 feet above base of Winterset limestone.
204. SE¼, NW¼, sec. 24, T. 57 N., R. 25 W.; 1.5 miles W of Utica, Livingston County, Missouri: road cut along hill, on S side of State Highway No. 36. Shale parting about middle of Bethany Falls limestone.
205. Midway along E boundary of NW¼, sec. 17, T. 57 N., R. 25 W.; 1 mile NW of Mooresville, Livingston County, Missouri; quarry just W of road bend between E-W and N-S stretches of road. Shale parting 8 feet, 6 inches below top of Bethany Falls limestone; Stark shale, 2 feet below top, and 6 inches below top.
206. NE¼, NE¼, sec. 1, T. 58 N., R. 25 W.; 0.2 mile SW of Spring Hill, Livingston County, Missouri; quarry just W of County Highway A. Collection 6 inches below top of Stark shale.
207. NE¼, SW¼, sec. 7, T. 59 N., R. 25 W.; 5.5 miles NW of Spring Hill, Livingston County, Missouri; creek cut a short distance W of Chicago, Rock Island, and Pacific Railroad, about 600 feet S of bridge. Hushpuckney shale, top; shale parting 1 foot, 4 inches above base of Bethany Falls limestone.
208. SW¼, SW¼, sec. 3, and SE¼, SE¼, sec. 4, T. 59 N., R. 28 W.; 4.5 miles NW of Gallatin, Daviess County, Missouri; exposures along valley on both sides of bridge and N-S road. Collections 11 feet below top of Wea shale to 3 feet below top of Wea; Quivira shale, base.
210. NE¼, NW¼, SW¼, sec. 18, T. 57 N., R. 30 W.; 4.1 miles W of N edge of Cameron,

DeKalb County, Missouri; road cut S side of State Highway No. 36, and valley slope immediately S of the highway. Eudora shale, top; shale parting, 2 feet below top of Stoner limestone.

212. NW¼, NW¼, sec. 27, T. 56 N., R. 28 W.; 0.3 mile S of Kingston, Caldwell County, Missouri; quarry just W of State Highway No. 13. Shale parting 20 feet below top of Bethany Falls limestone.

213. SE¼, SE¼, sec. 19, T. 51 N., R. 28 W.; 0.6 mile NW of Fleming, Ray County, Missouri; gully in Missouri River valley bluff, 100 to 200 feet N of County Highway E. A few feet below top of Pleasanton shale.

214. SE¼, NW¼, sec. 14, T. 51 N., R. 29 W.; 1 mile N of Orrick, Ray County, Missouri; quarry section high on bluff, N of NW-SE road. Shale parting 6 feet, 6 inches above base of Bethany Falls limestone.

216. N½, N½, sec. 9, T. 52 N., R. 28 W.; 1 mile SE of Rayville, Ray County, Missouri; outcrops near head of valley, immediately W of N-S road. Hushpuckney shale, top.

218. NW¼, SW¼, sec. 34, T. 54 N., R. 29 W.; 2.3 miles E of N edge of Lawson, Ray County, Missouri; creek outcrops, beginning just E of County Highway C, extending eastward and northeastward; about 0.1 mile N and NE of junction of County Highways C and D. Chanute shale, top; Muncie Creek shale, top; shale parting, 10 inches above base of Raytown limestone.

219. Center, N½, sec. 20, T. 55 N., R. 31 W.; 2 miles E of Plattsburg, Clinton County, Missouri; quarry just N of State Highway No. 116, E of Little Platte River valley. Hickory Creek shale, top, to 3 feet below top of Spring Hill limestone.

220. N½, NE¼, sec. 24, T. 55 N., R. 32 W.; 0.2 mile E of Plattsburg, Clinton County, Missouri; road cut, E side of State Highway No. 116. Eudora shale, base.

221. NE¼, sec. 17, and W½, SE¼, sec. 8, T. 55 N., R. 31 W.; 2.5 miles NE of Plattsburg, Clinton County, Missouri; N and S of bridge, where E-W road crosses Little Platte River. Island Creek shale, top, to top of Eudora shale.

222. NE¼, sec. 33, T. 56 N., R. 31 W.; 3.5 miles W and slightly S of Turney, Clinton County, Missouri; outcrops along ravine which empties from the W into Little Platte River, and exposures in Little Platte River bank; all exposures within 0.2 mile S of E-W road. Collections 20 feet below top, and at top of Bonner Springs shale.

223. N½, NW¼, NE¼, sec. 17, T. 55 N., R. 30 W.; 3.5 miles SE of Turney, Clinton County, Missouri; quarry exposures immediately N of E-W road. Hickory Creek shale, top.

225. N½, N½, sec. 17, midway E-W in the section, T. 55 N., R. 32 W.; 0.8 mile NW of Sceares, Clinton County, Missouri; exposures E and W of creek, S of County Highways S-U. Shale parting about middle of Stoner limestone.

226. NE¼, NW¼, sec. 18, T. 55 N., 32 W.; 1.5 miles W of Sceares, Clinton County, Missouri; ravine section just S of County Highways S-U. Eudora shale, top.

227. About 0.1 mile W of center of sec. 26, T. 56 N., R. 34 W.; 3 miles E of Agency, Buchanan County, Missouri; road cut on County Highway H, near top of E bluff of Platte River valley, and quarry just S of the highway. Collections from 1 foot, 6 inches below top of Weston shale to top of the Weston.

228. Outcrops from mid-boundary of secs. 25 and 26 to mid-boundary of secs. 25 and 30, T. 56 N., R. 35 W.; 2 miles SW of Agency, Buchanan County, Missouri; ravine outcrops N of County Highway H. Vinland shale, top; three shale partings in Haskell limestone; Lower Lawrence shale, top.

229. W½, NW¼, NE¼, sec. 21, T. 55 N., R. 34 W.; 5 miles SE of Faucett, Buchanan County, Missouri; valley outcrops E of N-S road and bridge. A few inches below top of Eudora shale.

230. N½, SW¼, sec. 14, T. 54 N., R. 35 W.; 0.8 mile S of New Market, Platte County, Missouri; high bank on E side of State Highway No. 71. Weston shale, top; two shale partings from 1 to 2 feet above base of Iatan limestone.

231. About 0.2 of the distance from N to S along boundary between secs. 14 and 15, T. 53 N., R. 33 W.; 1.2 miles N of Smithville, Clay County, Missouri; on E side of State Highway No. 169; road cut, hill, and creek outcrops. Bonner Springs shale, top, to top of Eudora shale.

232. NW¼, NW¼, NE¼, sec. 19, T. 52 N., R. 34 W.; 4 miles SE of Platte City, Platte County, Missouri; creek cut just S of County Highway D. Eudora shale, top.

233. About 0.2 of the distance from N to S along boundary between sec. 31, T. 53 N., R. 34 W., and sec. 36, T. 53 N., R. 35 W.; 0.5 mile E of Platte City, Platte County, Missouri; road cut on E side of State Highway No. 71. Collections 2 feet below top of Weston shale, and 5 feet, 6 inches above base of Iatan limestone.

234. Approximately 0.1 mile S of center of sec. 26, T. 53 N., R. 35 W.; 0.3 mile SW of Tracy, Platte County, Missouri; road cut and hill outcrops just NW of State Highway No. 92. Eudora shale, top.

235. SW¼, SW¼, SE¼, sec. 28, T. 52 N., R. 35 W.; at W end of Farley, Platte County, Missouri; quarry exposures high on Missouri River valley bluff, and slope outcrops extending downward to flood plain below; few hundred feet E of State Highway No. 92. Collections from 3 feet, 6 inches below top of Farley limestone to 6 feet above base of Vilas shale.

236. At boundary of secs. 30 and 31, 0.2 of the distance from E to W along the boundary, T. 53 N., R. 35 W.; at Beverly Station, Platte County, Missouri; outcrops on N slope of high, steep hill, S of junction of

State Highways 45 and 92. Eudora shale, base, to 6 feet below top of Weston shale.

237. E½, SE¼, sec. 3, T. 53 N., R. 36 W.; 1.2 miles NW of Weston, Platte County, Missouri; Missouri River valley bluff, E of road. Collection 15 feet below top of Weston shale.

238. About the center of NW¼, sec. 34, T. 54 N., R. 36 W.; 2.8 miles NW of Weston, Platte County, Missouri; quarry at top of bluff, W of road and bridge. Clay parting 7 feet, 8 inches below top of Iatan limestone.

240. NE¼, NE¼, sec. 34, T. 55 N., R. 37 W.; 1 mile SE of Armour, Buchanan County, Missouri; about 0.4 mile N of Platte-Buchanan County line, in Buchanan County; Missouri River valley bluff outcrops, E of State Highway No. 45, E of Chicago, Burlington, and Quincy Railroad tracks. Collections in lower Lawrence shale and at base of Kanwaka formation.

241. 0.2 of the distance from E to W along boundary between secs. 27 and 34, T. 55 N., R. 37 W.; 0.3 mile E of Armour, Buchanan County, Missouri; Missouri River valley bluff outcrops, E of Chicago, Burlington, and Quincy Railroad tracks. lower Lawrence shale, top; upper Lawrence shale, base.

242. NW¼, SE¼, sec. 27, T. 56 N., R. 36 W.; 2 miles E of Halls, Buchanan County, Missouri; road cut, N side of E-W road. Near base and at top of Snyderville shale.

243. Midway along boundary between secs. 26 and 35, T. 59 N., R. 36 W.; 0.5 mile W of N edge of Amazonia, Buchanan County, Missouri; Missouri River valley bluff outcrops, NE of Chicago, Burlington, and Quincy Railroad tracks. Snyderville shale, base; two shale partings in Leavenworth limestone.

249. SW¼, SE¼, sec. 30, T. 54 N., R. 30 W.; 1.8 miles E of Holt, Clinton County, Missouri; ravine outcrop S of E-W road. Collection 5 feet above base of Lane formation.

250. SE¼, NE¼, sec. 36, T. 60 N., R. 25 W.; 2 miles ESE of Jamesport, Daviess County, Missouri; outcrops in valley, just W of bridge and N-S county-line road. Two shale partings in Block limestone.

REFERENCES

ADAMS, G. I., 1904, Geology of the Iola Quadrangle: U. S. Geol. Survey Bull. 238, pp. 1–83.

BASSLER, R. S., and KELLETT, BETTY, 1934, Bibliographic index of Paleozoic Ostracoda: Geol. Soc. America, Spec. Paper 1, pp. 1–500.

BRADFIELD, H. H., 1935, Pennsylvanian Ostracoda of the Ardmore Basin, Oklahoma: Bull. Am. Paleontology, vol. 22, no. 73, pp. 1–116.

BROADHEAD, G. C., 1866, Coal Measures in Missouri: St. Louis Acad. Science, Trans., vol. 2, pp. 311–333.

——, 1873, Geology of northwestern Missouri: Geol. Survey of Missouri, pt. 2, pp. 1–402.

——, 1895, Coal Measures of Missouri: Missouri Geol. Survey Bull. 8, pp. 353–395.

CLINE, L. M., 1941, Traverse of upper Des Moines and lower Missouri series from Jackson County, Missouri to Appanoose County, Iowa: Bull. Am. Assoc. Petroleum Geol., vol. 26, pp. 23–72.

COOPER, C. L., 1946, Pennsylvanian ostracodes of Illinois: Illinois Geol. Survey Bull. 70, pp. 1–177.

——, 1947, Microfossils in Pennsylvanian correlations: Jour. Geology, vol. 55, pp. 261–270.

CORYELL, H. N., and BILLINGS, GLADYS D., 1932, Pennsylvanian Ostracoda of the Wayland shale of Texas: Am. Midland Naturalist, vol. 13, pp. 170–189.

CORYELL, H. N., and BOOTH, R. T., 1933, Pennsylvanian Ostracoda; a continuation of the study of the Ostracoda fauna from the Wayland shale, Graham, Texas: Am. Midland Naturalist, vol. 14, pp. 258–278.

CORYELL, H. N., and OSORIO, G. A., 1932, Pennsylvanian Ostracoda, an ostracode fauna from the Nowata shale: Am. Midland Naturalist, vol. 13, pp. 25–40.

CORYELL, H. N., and SAMPLE, C. H., 1932, Pennsylvanian Ostracoda, a study of the ostracode fauna of the East Mountain shale, Mineral Wells, Texas: Am. Midland Naturalist, vol. 13, pp. 245–281.

——, 1933, *Bairdia angulata*, a new name (Pennsylvanian ostracode, Texas): Am. Midland Naturalist, vol. 14, p. 187.

DELO, DAVID M., 1930, Some Upper Carboniferous Ostracoda from the shale basin of western Texas: Jour. Paleontology, vol. 4, pp. 152–178.

——, 1931, Pennsylvanian Ostracoda from Hamilton County, Kansas: Washington Univ. Studies, n. ser., Sci. and Tech. no. 5, pp. 41–51.

GEIS, H. L., 1932, Some ostracodes from the Salem limestone, Mississippian, of Indiana: Jour. Paleontology, vol. 6, pp. 149–188.

GREENE, FRANK C., and SEARIGHT, WALTER V., 1949, Revision of the classification of the post-Cherokee Pennsylvanian beds of Missouri: Missouri Geol. Survey and Water Resources, Rpt. Inv. 11, pp. 1–21.

HARLTON, B. H., 1927, Some Pennsylvanian ostracodes of the Glenn and Hoxbar formations of southern Oklahoma and the upper part of the Cisco formation of northern Texas: Jour Paleontology, vol. 1, pp. 203–212.

——, 1928, Pennsylvanian ostracodes from Oklahoma and Texas: Jour. Paleontology, vol. 2, pp. 132–141.

——, 1929, Pennsylvanian Ostracoda from Menard County, Texas: Texas Univ. Bull. 2901, pp. 139–161.

——, 1929a, Some Upper Mississippian (Fayetteville) and Lower Pennsylvanian (Wapanucka-Morrow) ostracodes of Oklahoma and Arkansas: Am. Jour. Science, ser. 5, vol. 18, pp. 254–270.

——, 1931, New names for species of *Bairdia:* Jour. Paleontology, vol. 5, p. 163.

——, 1933, Micropaleontology of the Pennsylvanian Johns Valley shale of the Ouachita Mountains, Oklahoma, and its relationship to the Mississippian Caney shale: Jour. Paleontology, vol. 7, pp. 3–29.

HARRIS, R. W., and LALICKER, CECIL G., 1932, New Upper Carboniferous Ostracoda from

Oklahoma and Kansas: Am. Midland Naturalist, vol. 13, pp. 396–409.

HAWORTH, E., 1895, The stratigraphy of the Kansas Coal Measures: Am. Jour. Science, ser. 3, vol. 50, pp. 452–466.

HINDS, HENRY, 1912, The coal deposits of Missouri: Missouri Bur. of Geol. and Mines, 2d. ser., vol. 11, pp. 1–503.

——, 1917, Description of the Leavenworth and Smithville quadrangles (Mo.-Kans.): U. S. Geol. Survey, Leavenworth-Smithville folio no. 206, pp. 1–13.

——, and GREENE, E. C., 1915, The stratigraphy of the Pennsylvanian series in Missouri: Missouri Bur. of Geol. and Mines, vol. 13, 2d. ser., pp. 1–255.

——, JEWETT, JOHN M., and NEWELL, NORMAN D., 1935, The geology of Wyandotte County, Kansas: Kansas Geol. Survey Bull. 21, pt. 2, pp. 151–205.

JOHNSON, W. R., 1936, The Ostracoda of the Missouri series in Nebraska: Nebraska Geol. Survey Paper 11, pp. 1–52.

KELLETT, BETTY, 1929, The ostracode genus *Hollinella*, expansion of the genus and description of some Carboniferous species: Jour. Paleontology, vol. 3, pp. 196–217.

——, 1933, Ostracodes of the Upper Pennsylvanian and Lower Permian strata of Kansas, I: the Aparchitidae, Beyrichiidae, Glyptopleuridae, Kloedenellidae, Kirkbyidae, and Youngiellidae: Jour. Paleontology, vol. 7, pp. 59–108.

——, 1934, Ostracodes from the Upper Pennsylvanian and Lower Permian strata of Kansas, II, The genus *Bairdia:* Jour. Paleontology, vol. 8, pp. 120–138.

——, 1935, Ostracodes of the Upper Pennsylvanian and Lower Permian strata of Kansas, III: Bairdiidae (concluded), Cytherellidae, Cypridinidae, Entomoconchidae, Cytheridae, and Cypridae: Jour. Paleontology, vol. 9, pp. 132–166.

——, 1936, Carboniferous ostracodes: Jour. Paleontology, vol. 10, pp. 769–784.

KIRKBY, J. W., 1858, On Permian Entomostraca from the fossiliferous limestone of Durham: Annals and Mag. Nat. History, ser. 3, vol. 2, pp. 317–330, 432–439.

——, 1862, On some additional species that are common in the Carboniferous and Permian strata: Annals and Mag. Nat. History, ser. 3, vol. 10, pp. 212–215.

KNIGHT, J. B., 1928, Some Pennsylvanian ostracodes from the Henrietta formation of eastern Missouri: Jour. Paleontology, vol. 2, pp. 229–267, 318–336.

MCCOURT, W. E., ALBERTSON, M., and BENNETT, J. W., 1917, The geology of Jackson County (Missouri): Missouri Bur. of Geol. and Mines, vol. 14, pp. 1–158.

MCQUEEN, H. S., and GREENE, F. C., 1938, The geology of northwestern Missouri: Missouri Geol. Survey and Water Resources, vol. 25, 2d. ser., pp. 1–217.

MOORE, R. C., 1932, A reclassification of the Pennsylvanian system in the northern Mid-Continent region: Kansas Geol. Soc. Guidebook, Annual Field Conference, pp. 79–98.

——, 1936, Stratigraphic classification of the Pennsylvanian rocks of Kansas: Kansas Geol. Survey Bull. 22, pp. 1–256.

——, et al., 1944, Correlation of the Pennsylvanian formations of North America: Geol. Soc. America Bull., vol. 55, pp. 657–706.

——, 1948, Classification of Pennsylvanian rocks in Kansas, Missouri, Nebraska, and northern Oklahoma: Bull. Am. Assoc. Petroleum Geol., vol. 32, pp. 2011–2040.

NEWELL, NORMAN D., 1935, The geology of Johnson and Miami counties, Kansas: Kansas Geol. Survey Bull. 21, pt. 1, pp. 7–150.

PAYNE, KENNETH A., 1937, Pennsylvanian Ostracoda from Sullivan County, Indiana: Jour. Paleontology, vol. 11, pp. 276–288.

ROTH, ROBERT, and SKINNER, JOHN, 1930, The fauna of the McCoy formation, Pennsylvanian, of Colorado: Jour. Paleontology, vol. 4, pp. 332–352.

——, 1931, *Bairdia coryelli*, new name for *Bairdia ventricosa:* Jour. Paleontology, vol. 5, p. 48.

SARS, G. O., 1926, Crustacea of Norway: vol. 9, Ostracoda. Bergen.

SCOTT, H. W., 1944, Muscle scar patterns on some Upper Paleozoic ostracodes: Jour. Paleontology, vol. 18, pp. 162–171.

——, and BORGER, H. D., 1941, Pennsylvanian ostracodes from Lawrence County, Illinois: Jour. Paleontology, vol. 15, pp. 354–358.

SYLVESTER-BRADLEY, P. C., 1950, The shell of the ostracod genus *Bairdia:* Annals and Mag. Nat. History, ser. 12, vol. 3, pp. 751–756.

ULRICH, E. O., and BASSLER, R. S., 1906, New American Paleozoic Ostracoda. Notes and descriptions of Upper Carboniferous genera and species: U. S. Nat. Museum Proc., vol. 30, pp. 149–164.

——, 1923, Silurian, Maryland Geol. Survey, pp. 118–391.

UPSON, M. E., 1933, The Ostracoda of the Big Blue series in Nebraska: Nebraska Geol. Survey Bull. 8, pp. 1–54.

WARTHIN, A. S., JR., 1930, Micropaleontology of the Wetumka, Wewoka, and Holdenville formations: Oklahoma Geol. Survey Bull. 53.

WELLER, J. M., 1947, Invertebrates in Pennsylvanian correlations: Jour. Geology, vol. 55, pp. 254–260.

——, WANLESS, H. R., CLINE, L. M., and STOOKEY, D. G., 1942, Interbasin Pennsylvanian correlations, Illinois and Iowa: Am. Assoc. Petroleum Geol. Bull. vol. 26, pp. 1585–1593.

WILMARTH, M. GRACE, 1938, Lexicon of geologic names of the United States: U. S. Geol. Survey Bull. 896.

WILSON, C. W., JR., 1933, Fauna of the McAlester shale, Pennsylvanian, of Muskogee County, Oklahoma: Jour. Paleontology, vol. 7, pp. 412–422.

WILSON, MALCOM E., 1922, The occurrence of oil and gas in Missouri: Missouri Bur. of Mines and Geology, vol. 16, 2d ser.

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UNUSUAL SPECIMENS OF THE BRACHIOPOD FAMILY ISOGRAMMIDAE

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ABSTRACT—Two new species of *Isogramma*, an unusual Pennsylvanian brachiopod genus, are described. One species, *I. renfrarum*, was pieced together from loose fragments and proves to be the largest species of the genus yet found. The other, *I. texanum*, shows the scars of the muscles of the pedicle valve, an internal feature hitherto unknown. A new genus of Permian brachiopod *Megapleuronia* from Sicily is also described. This shows its relationship to the Isogrammidae by its peculiar foramen, strongly punctate shell and concentric fila. It differs from *Isogramma* in being strongly plicate and having a muscle platform in the brachial valve. Besides the genotype *M. fabianii* Greco, another new species *M. grecoi* is proposed.

WHILE collecting fossils from Pennsylvanian rocks of North Central Texas with Mrs. J. H. Renfro and her daughter Millicent, of Fort Worth, Texas, I noticed many fragments of the brachiopod *Isogramma* lying in the soil. These occurred in a number of formations at several localities. They are easy to recognize by the strong elevated concentric lines on the exterior and the coarsely and densely pitted internal surface. Most of the pieces indicated a shell too thin to remain complete under the rigors of weathering. Nevertheless the abundance and excellent preservation of the pieces aroused the hope that a specimen showing the form and other details of the animal might be found.

In the Gonzales shale at the well-known locality 3.9 miles northwest of Finis in Young County, Texas, fragments of *Isogramma* are exceptionally common. Here a small pile of pieces was discovered which included a fairly large fragment preserving the cardinal process (pl. 21 fig. 3). In the hope of discovering the nature of this shell, I put the pieces into a sack and dug up a generous portion of the surrounding shale. This was washed in the laboratory and all of the *Isogramma* fragments separated. Then, in odd moments, an attempt was made to assemble the shell. Some of my colleagues took an interest in the matter and several of them assisted in fitting the pieces together. Some of the pieces never were fitted but enough were joined together to show the form of this high Pennsylvanian *Isogramma*. The result is an unusually large brachiopod represented by a nearly complete brachial valve but unfortunately lacking most of the pedicle valve.

The numerous scattered fragments of *Isogramma* occurring in the high Pennsylvanian shales are more easily understood when one sees the large size and fragile nature of the whole shell. This is one of the largest brachiopods yet found in North America and is the largest known species of the genus.

The assembled pieces were photographed and a reconstruction made which is figured in the plates herewith. Copies of this reconstruction were sent to my sharp-eyed friends the Renfros in the hope that they might find other promising piles of pieces. Instead they produced several complete specimens from Strawn sandstones 0.8 mile south of Kickapoo Falls, Hood County. In all, nine specimens were found, all but one of which are brachial valves. These are in the form of imprints of the exterior on the sandstone surface. The shell itself is not preserved. One fragmentary pedicle valve shows an impression of the beak area and thus furnishes some information on the nature of this part of the species. These specimens are not well preserved but they do show the original form of the species in one piece and corroborate it as one of the largest known brachiopods.

In addition to the fragments found in Young County and other parts of North Central Texas I collected specimens of

another but smaller species of *Isogramma* from a sandstone in the Gaptank formation of West Texas. The internal features of the pedicle valve are well enough preserved to warrant some remarks on their interpretation. The Gaptank specimens represent a new species which is described herein.

Isogramma is such an unusual and rare brachiopod that considerable interest attaches to new occurrences. Genera related to *Isogramma* are known, such as *Dictyonella* of the Silurian and *Eichwaldia* of the middle Ordovician. These all have a similar umbonal region. I am here adding a fourth genus, described as new, and based on a form from the Permian of Sicily, which was recently proposed as a new species of *Productus*. This genus, here called *Megapleuronia*, is unlike *Isogramma* in its strongly costate surface but it has a similar umbonal scar on the pedicle valve, is coarsely punctate and marked by elevated concentric lines as in *Isogramma*.

ISOGRAMMA RENFRARUM Cooper, n. sp.
Plate 21, figures 1–3; plate 22, figure 1; plate 23, figure 1

Shell large for the genus, transversely semielliptical, width about 2 to 2½ times the length; hinge slightly less than the maximum shell-width; sides somewhat narrowly rounded. Cardinal extremities obtuse. Surface ornamented by narrowly rounded elevated concentric lines separated by spaces slightly wider than the lines. Nine of the concentric marks occupy a space of 5 mm. on mature parts of the shell.

Profile of pedicle valve gently convex; brachial valve gently concave with the maximum concavity located in the postero-median region.

Pedicle umbo marked by a triangular depressed area having an apical angle of 21°, a length of somewhat more than 20 mm. and a width of 10 mm. Triangular area divided by a narrow median groove. Areas on each side of median groove smooth.

Umbonal region of brachial valve concave, the concavity continued anteriorly for somewhat less than half the valve length. Anterior half gently concave; lateral areas nearly flat.

Interior with cardinal process and median septum well preserved. Shaft short; myophore somewhat pentagonal in outline, the portion facing the pedicle valve narrowly rounded in front but the opposite side tapering to a blunt point. A slight depression occurs in the angular side toward the brachial valve and ends at the posterior margin. Myophore surface concentrically marked by lines of growth but individual muscle scars not recognizable. Anterior end of shaft forked, each prong of the fork low and narrow and extending for a short distance on each side of the posterior end of the median ridge. The prongs thus define a shallow and narrow depression in the part of the shaft facing the pedicle valve. Median ridge short, increasing in height anteriorly but not extending to the middle. Adductor marks indistinct and not separable. Sockets forming shallow depressions extending anterolaterally from each side of the shaft.

The measurements below are inexact for the restored specimen because the outlines are reconstructed. Measurements in centimeters:

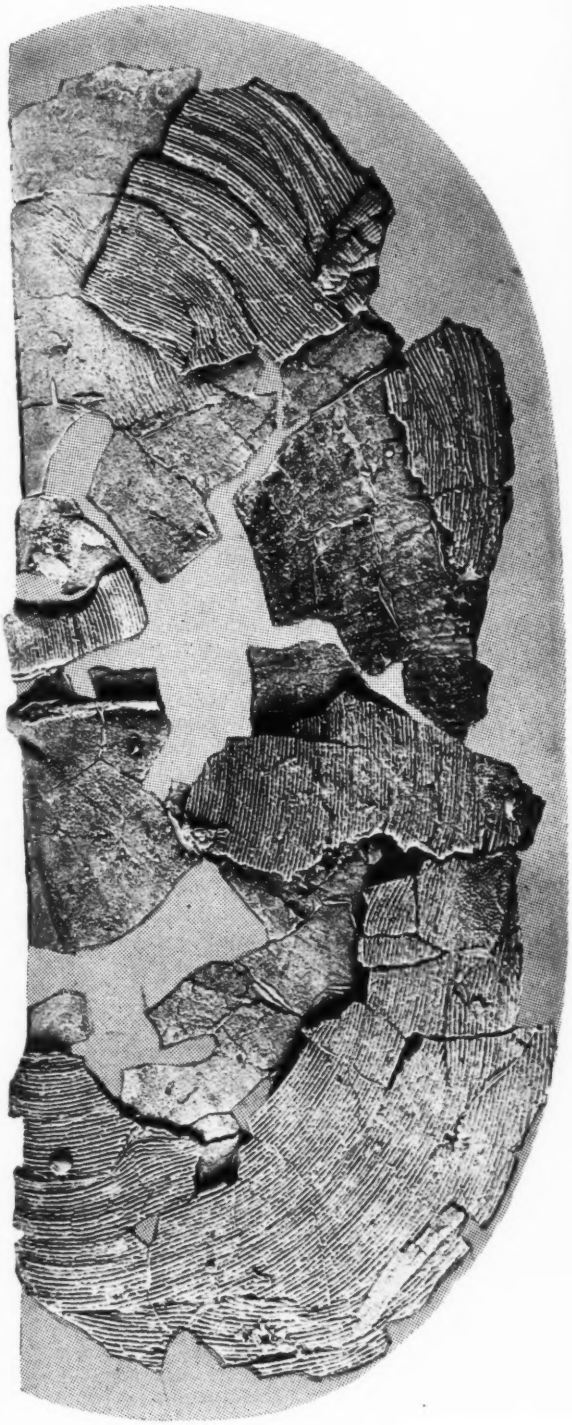
EXPLANATION OF PLATE 21

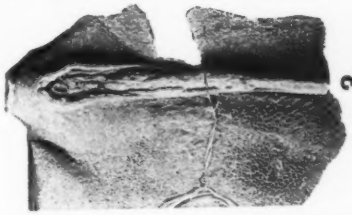
FIGS. *1–3*—*Isogramma renfrarum* Cooper, n. sp. *1*, holotype, USNM 111687, showing exterior of the incomplete pedicle valve and the interior of the brachial valve. Note cardinal process and median septum inserted in shaft, ×1. *2*, posterior of portion of brachial valve of holotype showing myophore of cardinal process, articulating process or brachial socket, ×2. *3*, cardinal process and median ridge of holotype, ×2, showing insertion of septum into shaft of cardinal process. Coarse pits of the interior surface may be seen on the lower part of the picture on each side of the median ridge. (p. 114)

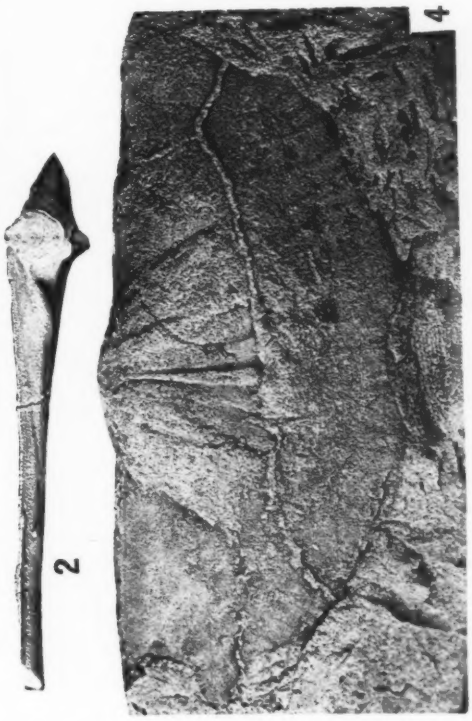
Gonzales shale, 3.9 miles northwest of Finis, Young County, Texas.

4, 5—*Isogramma texanum* Cooper, n. sp. *4*, impression of the interior of the pedicle valve, ×2, showing impression of inner platform. The median ridge is the filling of an elongate pit in the plate. The long and wide diductor scars appear on each side of the inner plate. Holotype USNM 111688a. *5*, part of a slab showing several young individuals, impressions of the brachial exterior, ×1, paratype USNM 111688c.

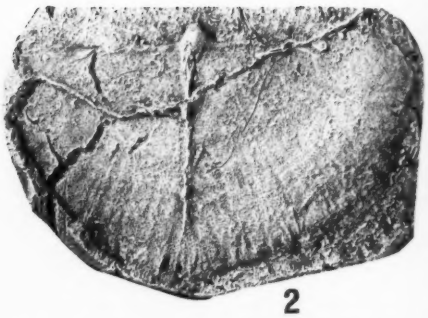
Gaptank formation (near top bed 10), 1.7 miles southeast of Gaptank, 21½ northeast of Marathon, Texas. (p. 115)

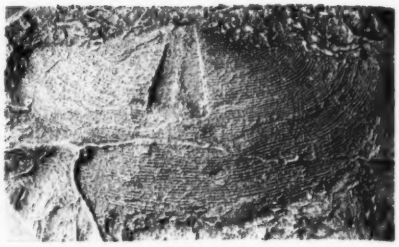


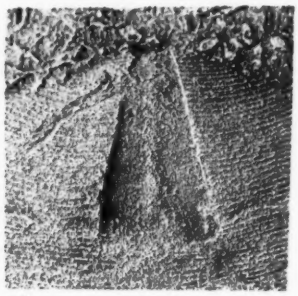




Cooper, unusual isogrammid brachiopods







Cooper, unusual isogrammid brachiopods

	length	*width at middle*	*hinge-width*
Holotype	7.9	18.3	17.5
Paratype 111929a	5.8	15.3	15.2
Paratype 111929e	7.3	16.0	?

Holotype USNM 111687; figured paratype USNM 111929a; unfigured paratypes USNM 111929b–i.

Horizon and locality.—Gonzales shale, 3.9 miles northwest of Finis, Young County, Texas. Strawn sandstone, 0.8 mile south of Kickapoo Falls, Hood County, Texas.

Discussion.—This species differs from *Isogramma millepunctata* Meek and Worthen by its greater size, proportionately smaller cardinal process, broadly convex lateral margins and stronger ornamentation. It differs from *I. texanum* n. sp. in its greater size and coarser ornamentation.

The exterior view of the brachial valve (pl. 22, fig. 1) on the right center of the specimen shows an interesting example of injury and repair. The concentric lines loop posteriorly and are spread farther apart than usual in the repaired area. A similar repaired area occurs in the left center of the shell.

ISOGRAMMA TEXANUM Cooper n. sp.
Plate 21, figures 4, 5; plate 22, figures 2–4

Isogramma millepunctata DUNBAR. (not Meek and Worthen) Nebraska Geol. Surv. Bull. 5, 2nd ser. 1932, p. 282 (part), pl. 42, fig. 21.

Shell wider than long; width about double the length; hinge straight, narrower than the greatest shell-width; sides narrowly rounded; anterior and anterolateral margins broadly rounded. Greatest width located about ⅓ the length anterior to the hinge-margin. Surface marked by fine concentric, elevated lines, 12 in 5 mm. or four or five occupying a space of 2 mm. on the body of the shell. The fine lines are separated by spaces about twice as wide as the elevated lines. Pedicle valve moderately to strongly convex in lateral profile with the greatest convexity located in the posterior half and with the anterior third sloping moderately to the anterior margin. Anterior profile broadly convex with the median third broadly rounded and the lateral two-thirds descending by long moderate slopes to the lateral margins. Umbonal region somewhat inflated; median region inflated, with the slopes to the cardinal extremities only moderately steep. Pedicle region defined by a triangular area that is twice as long as wide and has an apical angle of 25° to 30°. Triangular area slightly depressed and marked medially by a narrow, low ridge.

Brachial valve gently concave with the maximum concavity located in the posteromedian area. Lateral and anterior regions very slightly concave or flat.

Pedicle interior marked by a triangular slightly elevated adductor platform flanked on each side by fairly broad but elongate diductor impressions. Adjustor (?) impressions small, oblique, located on the posterolateral side of the diductors. Median adductor depression shallow and extending to about the middle.

Brachial interior with a moderately stout

EXPLANATION OF PLATE 22

FIG. *1*—*Isogramma renfrarum* Cooper, n. sp. *1*, exterior of the brachial valve of the holotype, ×1, showing concentric ornamentation. Old repaired injuries appear on the extreme right, in the lower right center and in the left center. (p. 114)
Horizon and locality same as preceding plate, fig. *1*.

2–4—*Isogramma texanum* Cooper, n. sp. *2*, rubber replica of the interior of the brachial valve showing median septum and fairly high cardinal process, ×I. Note same insertion of septum into shaft of cardinal process as in *I. renfrarum*, paratype USNM 111688b. *3*, rubber replica of the exterior of the pedicle valve, holotype, ×1, showing concentric lines and triangular area. *4*, triangular area of preceding, ×2. (p. 115)
Horizon and locality same as preceding plate, figs. *4*, *5*.

5–7—*Megapleuronia grecoi*, Cooper, n. sp. *5*, beak region of holotype USNM 116347b seen from the brachial side, ×2, and showing posterior of triangular area with its deltoid covering plate. *6*, posterior of holotype showing triangular area and strong concentric lines, ×2. *7*, view of the pedicle valve of a young specimen, paratype USNM 116347c showing triangular area occupying nearly the posterior half of the valve, ×1. (p. 119)
Permian (Sossio limestone), Pietra di Salamone, Palazzo Adriana, Sosio Valley, Sicily.

cardinal process having a short but stout shaft enclosing a thin median ridge which extends nearly to the front margin. Cardinal edge on each side of the cardinal process thickened laterally for a short distance. Muscular and pallial impressions present but indistinct.

Measurements in millimeters: holotype (pedicle valve), length 26.6, greatest width 57.0, height 8.4, width of triangular area 7.5, length of same 14.0 plus. Paratype USNM (incomplete brachial valve), length 33.5, half-width of 31.6 mm equals probable true width 63.2.

Holotype USNM 111688a; figured paratypes USNM 111688b–c; unfigured paratypes USNM 111688d–n.

Horizon and locality.—Gaptank formation (bed near top of bed 10 of P. B. King's section), small knob 1¼ miles east of a point on the Fort Stockton Road 1½ miles north of the right-angled bend 2¼ miles east of the Montgomery Ranch, about 21½ miles from Gaptank (airline) northeast of Marathon, Texas.

Discussion.—Although the specific characters of *Isogramma millepunctata* Meek and Worthen, the only previously described American species, are not well known, *I. texanum* differs from the Illinois specimens in several particulars. The Texas shell is more convex in lateral profile and consequently deeper. It also has finer ornamentation and more narrowly rounded lateral extremities. It also has a more elevated cardinal process than *I. renfrarum.*

Notes on the structure of Isogramma.—Well preserved specimens of *Isogramma* are so rare that many details of its anatomy have never been made clear since the genus was defined. The shells are so fragile, too, that most specimens occurring in shaly rocks are broken to pieces and only the fragments showing the characteristic punctae and concentric lines are to be found. Specimens occurring in sandstone or limestone are usually more complete but seldom show many anatomical details. The specimens figured herein are exceptional in exhibiting features hitherto not seen or not so well preserved.

The fragility of of these peculiar shells makes it very difficult to prepare the internal structures of specimens preserved in limestone. Shells enclosed in sandstone however can be made to reveal their internal lamellae and other features by dissolving the calcareous shell of the fossils, thus leaving impressions of the inner and outer surfaces. The sandstone from the Gaptank formation is somewhat calcareous, fine-grained and proved an ideal medium for such treatment. Most of the specimens illustrated were treated in this manner and the impressions produced proved very faithful.

In the useful monograph by Aigner and Heritsch (1931) most of the important figures scattered through the literature have been brought together and can be readily compared. In addition interesting specimens from the southern Alps are figured for the first time. Since 1931 no extensive monograph of the genus has appeared although it has been mentioned by several authors.

One of the points of anatomy never made clear is the location and arrangement of of the pedicle muscles. According to Barrois (1882, p. 327) these were confined to the triangular platform which extends from the beak approximately to the middle of the valve. According to him both adductors and diductors were located on the platform. This makes a very narrow field of attachment for the muscles and is quite unlike the pedicle musculature of other similarly shaped large, flat and thin-bodied shells. In *Chonetes, Strophomena, Hipparionyx* and some other flattish brachiopods the diductor muscle scars are broad and flabellate and often cover a substantial portion of the internal surface. Two specimens of *I. texanum* n. sp. indicate that Barrois and others had material too imperfect to illustrate the full musculature of the pedicle valve.

A specimen from the Gaptank formation prepared by dissolving away the shell substance of the brachiopod yielded interior and exterior molds of unusual detail. (pl. 21, fig. 4) The internal impression shows an imprint of the surface of the triangular platform but on each side of it is a long subflabellate diductor scar. The anterior ends of these scars are located at about the anterior end of the platform. In the umbonal chamber and lying on the outside of each diductor occurs a short scar that may repre-

sent the attachment place of the adjustor muscles. These two scars on the specimen in question are not well preserved and confirmation is needed from additional specimens.

The platform on the inside of the valve is somewhat wider than on the exterior. It is marked centrally by a low narrow depression that widens gradually in an anterior direction. This depression appears as a low ridge on the internal mold. On the sides of the triangular plate appear two elongate scars, interpreted by Barrois as the diductors, which are here considered to be adductor scars. Additional marks appear on each side of the central depression which may be accessory diductor impressions but they are too indistinct to be sure.

Aigner and Heritsch (1931) present pictures of internal molds of pedicle valves which show most of the features of the Texas specimens. Figure 37 on plate 3 shows an impression of the platform with the elongate ridge representing the central groove and on each side of the platform, the large subflabellate diductors are clearly visible.

No definite scars of the adductors were detected on the interior of the brachial valve. Possible faint elongate scars located on each side of the median septum occur in one specimen (USNM 111688f) and suggest the position of the adductors. This suggested location is not in accord with the scars as figured by Dittmar (1871), which appear farther away from the septum than one would expect in brachiopods.

Both species figured herein show a fairly uniform structure to the cardinal process. This consists of a flattened somewhat rhomboidal myophore resting on a short expanded shaft which in some specimens is much swollen. The shaft extends anteriorly into the long but low median septum. At the junction of shaft and septum is an excavated area which in some specimens actually makes a small hollow chamber. The sides of the shaft seem to wrap around the end of the septum but do not completely cover it. This is apparently not an accidental feature because the specimens of both species described herein show it. The myophore is divided centrally by a faint groove which separates the diductor attachments. Muscle scars are not clearly shown but the surface of the myophore shows concentric elevated growth ridges.

The shaft of the cardinal process is separated from the side of the shell by a moderately deep and narrow groove. The latter is bounded on its outside by a low swelling which occupies the position of the crural base in other brachiopods. This swelling may serve a double purpose: attachment for the brachial processes and a possible accessory articulating process.

One of the unusual features of this genus is the strongly punctate or spongy interior of the shell. These punctae, according to the specimens available, are a feature of the interior only. The punctae as revealed by *I. renfrarum* are not like the common punctae of the Orthidae or Terebratulacea. In the latter two groups the punctae are generally somewhat distantly spaced from one another, or if the shell is costated may be arranged in rows. The punctae of *I. renfrarum* however are closely crowded with thin walls separating one cell from its neighbors. The punctae, moreover, are not of uniform size or shape.

Genus MEGAPLEURONIA Cooper, n. gen.

Shell large, attaining a width of over 2 inches, shell-substance thick; outline elliptical; profile concavo-convex to biconvex, the pedicle valve having the greater depth; anterior commissure rectimarginate; surface costate with or without a gentle wave toward the pedicle valve; strong elevated concentric threads or fila covering all parts; shell substance coarsely punctate.

Pedicle valve strongly convex; umbo arched and marked by an inserted flattened triangular area like that of *Dictyonella*. Details of interior unknown.

Brachial valve having a long median septum extending nearly to the front margin, anterior half of septum supporting a fairly large muscle platform; posterior half of septum continuous with long thick shaft of cardinal process; myophore not known.

Genotype: *Productus fabianii* Greco, 1947. (For illustration see plate 23, figs. 8–10).

Discussion.—The closest relative of this genus so far known is *Isogramma*. Similarities are to be seen in the nature of the pedicle umbo, the elevated concentric threads

covering the entire surface and the strongly pitted interior surface of the shell. The pedicle umbo of *Megapleuronia* is marked by what seems to be a decorticated area. This is a natural feature of the shell and not a peeled region; it is like that of *Dictyonella*, *Eichwaldia* and *Isogramma*. In the Sicilian specimens this area occupies about one-half the shell-length in a young specimen but as growth continues and the umbo swells, the depressed area seems to migrate to the rear and occupies less of the shell-length, about one-third in the largest specimen studied. This triangular area is nearly smooth and is bounded by a strong costa on each side. These costae are nicely rounded and show concentric threads on the part facing the triangular area. They thus show no signs of decortication. The anterior side of the triangle is irregular but an anterior projection to form a small lobe seems to be indicated. The surface of the triangular area is smooth but the substance of the shell forming it is finely punctate and the punctae are arranged in closely spaced rows. The apex of the triangle is marked by an impunctate layer that grows anteriorly flush with the costae forming the sides of the triangle. The anterior edge of this plate is concave posteriorly and suggests or is similar to a deltidial cover.

At the present writing it is not known what the function of this triangular area in *Isogramma* and *Megapleuronia* was. Its position suggests that it was the site of pedicle attachment. The similar area of *Eichwaldia* has been so interpreted. Hall and Clarke (1894, p. 310) figure a specimen with a long projection extending from it which is said to be a pedicle. This is a possible explanation for this type of structure but the point cannot be conclusively demonstrated.

The specimens figured herein are ornamented by strong, elevated interrupted concentric lines which are suggestive of the concentric ornamentation of *Isogramma*, well figured on plate 22, figure 1. The youngest specimen (pl. 23, fig. 3) and the youngest part of that specimen show the concentric lines well developed. This portion of the shell is most suggestive of *Isogramma* ornamentation.

The beak of the pedicle valve is strongly incurved, small and sharp and overhangs the umbo of the brachial valve. Under the beak is a wide and short flattened region suggesting an interarea. In the largest specimen this is much reduced and it is difficult to say whether or not it is a real interarea or if it is merely a concave region developed by the movements of the brachial valve when opening and closing.

An odd feature of the shells under consideration is the occurrence of specimens with concave brachial valves and others with a moderately convex brachial valve. The only interiors at present known are those of the convex kind. Greco (1947, pl. 1) figures specimens of both kinds but illustrates the interior of the convex type only A study of the exterior of the convex shell figured herein (pl. 23, fig. 8–10) shows that in its early stages it was concave and that

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EXPLANATION OF PLATE 23

FIG. *1*—*Isogramma renfrarum* Cooper, n. sp. *1*, impression of the brachial exterior on which is superimposed some of the interior details such as the median septum and cardinal process, ×1, paratype USNM 111929a. (p. 114)

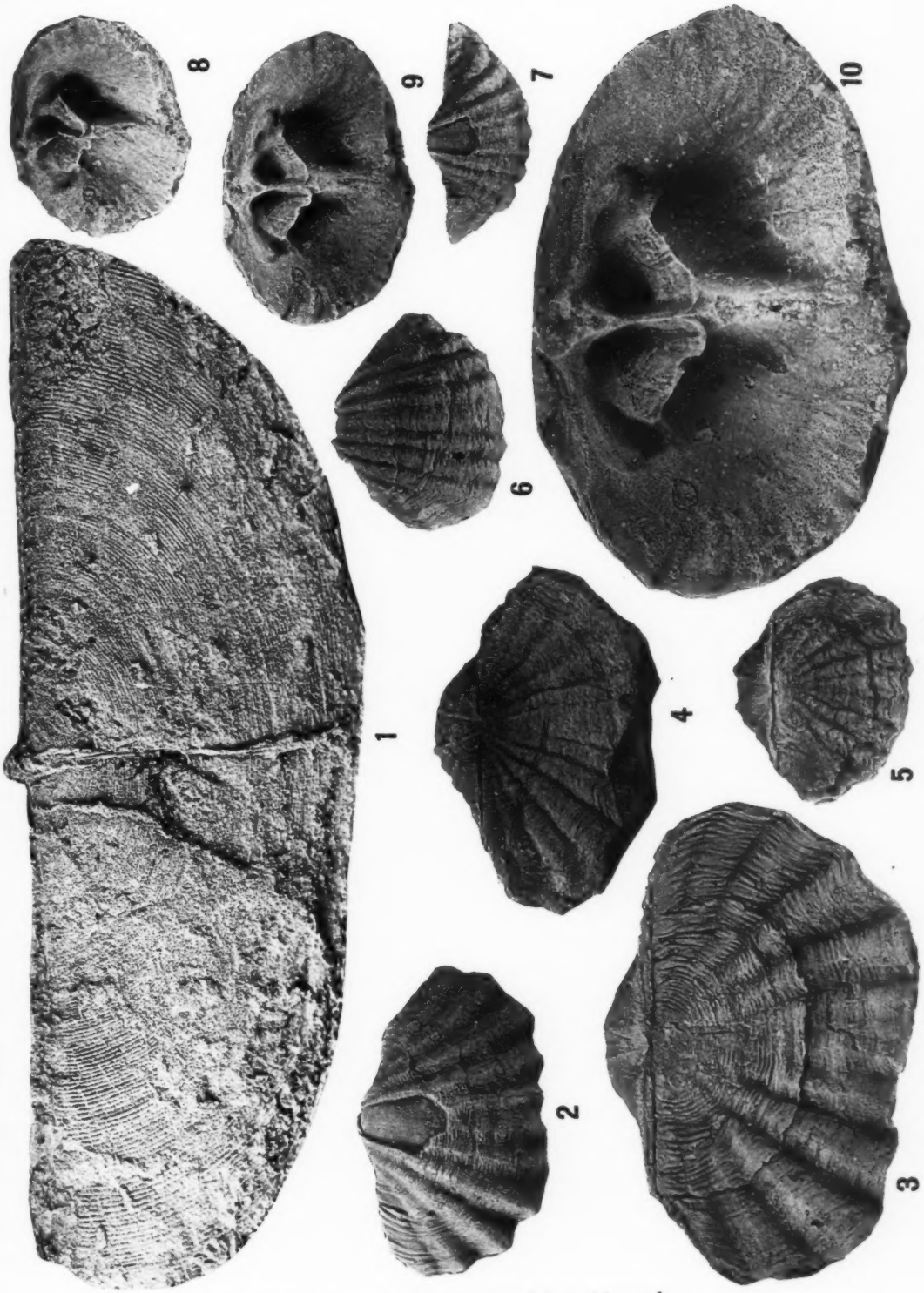
Strawn sandstone, 0.8 mile south of Kickapoo Falls, Hood County, Texas.

2–7—*Megapleuronia grecoi* Cooper, n. sp. *2*, exterior of the pedicle valve of the young paratype USNM 116347c shown on the previous plate fig. *7*, showing the triangular inset area in greater detail, ×2. *3*, brachial view of the preceeding, ×3, showing concentric, elevated lines. *4*, brachial exterior of a large specimen, ×1, paratype USNM 116347a. *5–7*, respectively brachial, pedicle and posterior views of a medium-sized individual, holotype USNM 116347b, ×1, showing triangular area confined to umbo. (p. 119)

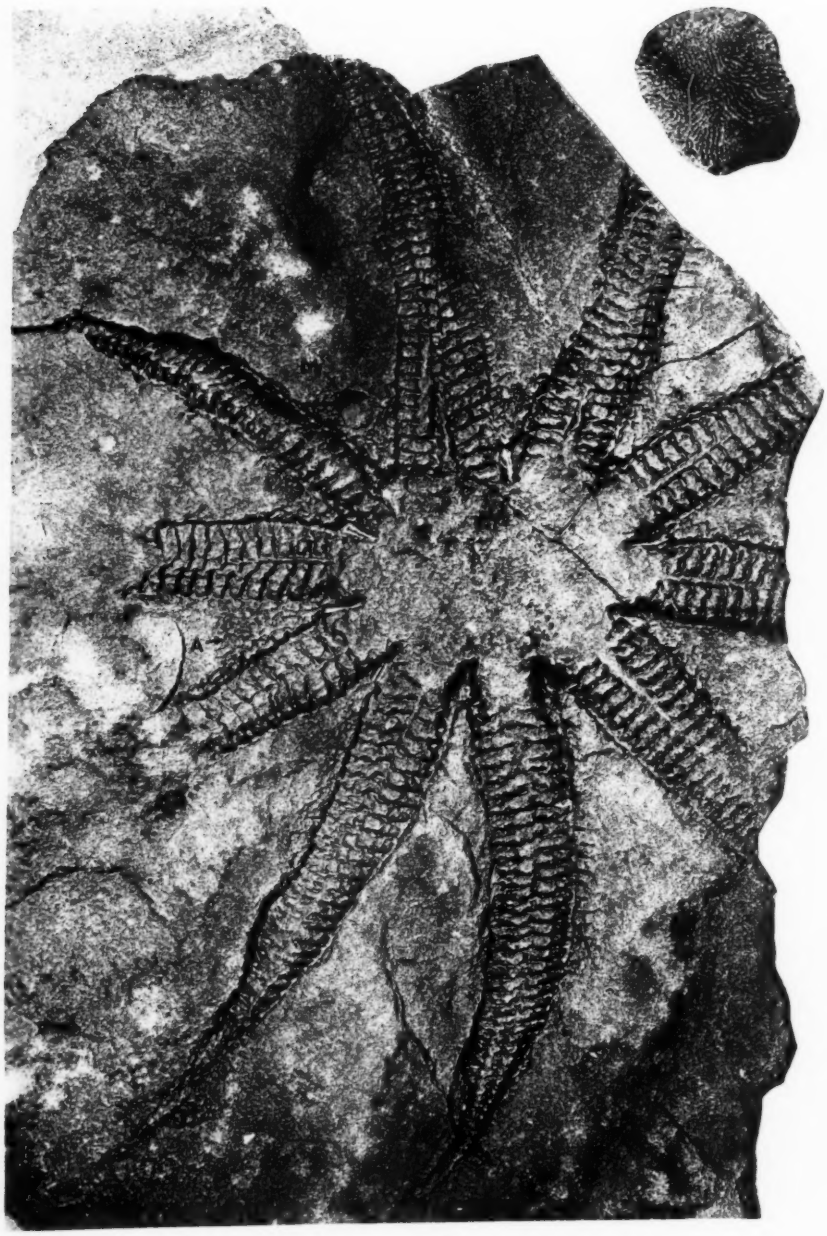
Horizon and locality same as preceding plate figs. *5–7*.

8–10—*Megapleuronia fabianii* (Greco) *8*, *9*, brachial interior turned partly to the side and seen in full view to show muscle platform, median septum and cardinal process, ×1, figured specimen USNM 116346. *10*, Same as the preceding enlarged ×2, and showing flattened area on each side of cardinal process. The coarse pits of the inner surface are visible along the anterior margin. (p. 119)

Permian (Sosio limestone), Pietra di Salamone, Palazzo Adriana, Sosio Valley, Sicily.



Cooper, unusual isogrammid brachiopods



Wells, Devonian starfish *Ptilonaster*

it gradually changed direction of growth to become convex. The largest specimen with concave brachial valve figured herein is nearly as big as the convex interior figured by Greco. It is possible that the species includes concavo-convex and biconvex forms but it is more likely that two species are involved.

The brachial interior presents a number of unusual features. The posterior surface may be an interarea but if so its surface is very uneven and bears two pairs of large pits. The inner pair of pits are narrow, oblique gashes on each side of the cardinal process. These suggest sockets for some sort of dental process. The outer pair of pits are large and irregular in outline. The floor of the pits shows obscure striation. None of this posterior surface is visible on the outside of the articulated shell, consequently it can be assumed that both sets of pits had something to do with articulating the valves. The cardinal process is suggestive of that of *Isogramma* but it has a longer and more elevated shaft. In *Megapleuronia* the shaft of the cardinal process extends anteriorly to the muscular platform and there unites with part of the median septum which divides the muscle platform into two parts.

The muscle platform is a concave plate supported by a thick median septum that extends nearly to the anterior margin. The platform has indistinct marks of two sets of muscles, an outer and an inner pair. This was probably not the full complement of muscles in the brachial valve however, because on each side of the muscle platform is located a somewhat oval scar deeply inserted in the shell substance. Anteriorly each scar is bounded by a low thickening which seems to be an additional support to the muscle platform. The muscle scars of the brachial valve of *Isogramma* are too little known to compare them with those of *Megapleuronia*.

In selecting a type specimen for *Productus fabianii* Greco in order to fix the genotype I have been guided by the fact that the interior details are known only in the convex form. Inasmuch as Greco (1947) did not fix a holotype I select the specimen illustrated by Greco on his plate 1, figures 2a, 2b. This specimen is a large example with a convex brachial valve like the one illustrated in this paper. The brachial interior, same plate figures 3a, 3b, becomes a paratype of *P. fabianii*.

MEGAPLEURONIA GRECOI Cooper, n. sp.
Plate 22, figures 5–7; plate 23, figures 2–7

I propose the name *Megapleuronia grecoi* for the concave type of shell described above. This differs from *M. fabianii* in possessing a concave valve in all its growth stages. I designate specimen USNM 116347b as holotype. Paratypes USNM 116347a, c. A specimen is figured by Greco (1947), plate 1, figs. 4a, 4b.

Horizon and locality.—Sosio limestone, Pietra di Salamone, Palazzo Adriano, Fiume del Sosio, Palermo, Sicily.

Discussion.—The fact that this concave form attains the same size as that of the convex species indicates that it is a different species with unlike growth habit.

REFERENCES

AIGNER, G. and HERITSCH, F., 1931, Das Genus *Isogramma* im Carbon der Südalpen: Denkschr. Akad. Wissensch. Wien, Mat.-Naturwiss. Kl., Band 102, pp. 303–316, pls. 1–5.

BARROIS, C., 1882, Récherches sur les Terrains anciens des Asturias et de la Gallice, p. 326, pl. 16.

DAVIDSON, T., 1862, British Carboniferous brachiopods, p. 278, pl. 55.

——, 1884, British fossil brachiopods. Appendix to Supplements, p. 283, pl. 20.

DITTMAR, A. VON, 1871, Ueber eines Brachiopoden-Geschlecht aus dem Bergkalk: Verh. d. k. Akad. Wissensch. St. Petersburg, 2nd ser. vol. 7, p. 1, pl. i.

GRECO, B., 1947, La Fauna Permiana del Sosio. pt. 3. Productidae, Richthofenidae: Paleontogr. Italica, vol. 41 (n. ser. vol. 11), 1942–46, pp. 1–21, pl. 1.

HALL, J. and CLARKE, J. M., 1892, Genera of Palaeozoic Brachiopoda: Palaeont. New York, vol. 8, pt. 2, 1894, pp. 307–312.

MEEK, F. B. and WORTHEN, A. H., 1873, Geol. Survey Illinois, vol. 5 p. 568, pl. 25.

PAECKELMANN, W., 1930, Die Brachiopoden des deutschen Unterkarbons. pt. 1: Abhandl. d. Preuss. Geol. Landesanst., N. F., Heft 122, p. 210.

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See page 121 for description of plate.

JOURNAL OF PALEONTOLOGY, VOL. 26, NO. 1, PP. 120–122, PL. 24, JANUARY 1952

A SPECIMEN OF THE STARFISH *PTILONASTER* FROM THE UPPER DEVONIAN OF CENTRAL NEW YORK

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ABSTRACT—Description of a nearly complete specimen of the ten-rayed ophiuroid starfish, *Ptilonaster princeps* Hall, from the Upper Devonian (Senecan) Enfield formation in Tompkins County, New York.

INTRODUCTORY NOTE

THE first printed reference to fossils in the rocks of central New York State seems to have been made by John Bartram (1751, p. 36) who referred to many fossils seen on a hillside, apparently somewhere in Cortland County.[1] Since then, and especially during the past 115 years since the establishment of the Geological Survey of the State of New York, these rocks have proved to be a wonderfully rich treasure-trove of fossils. But even with the constant searching of the rocks by literally thousands of people, new or rare and interesting forms are still turning up. The subject of this note is not a new species but a remarkably well-preserved specimen of a starfish hitherto known from a single fragment. Like many of these rare forms it was discovered as a result of the operation of that useful scientific principle, serendipity. It was found in the spring of 1951 by two graduate students of conservation, Frances Burnett and Robert W. Dickerman, while they were searching a small stream valley for snakes. The writer is indebted to these students for their prompt recognition of the prize and its safe conveyance to the Paleontological Laboratory.

The writer is also obliged to Dr. Otto H. Haas of the American Museum of Natural History for having a latex cast and plaster mold of the holotype of *Ptilonaster princeps* prepared and sent for comparison.

HORIZON AND LOCALITY

The specimen was found at an elevation of about 1300 feet in a small stream valley descending the south side of Mount Pleasant, a hill on the north side of Ellis Hollow, the valley of Cascadilla Creek, five miles due east of the Cornell University Campus, Ithaca, New York. It was in a large fresh block in the bed of the stream and evidently not far from its source. The horizon at this spot is the middle of the Enfield formation about 400 feet below the base of the Chemung and nearly the same distance above the top of the Ithaca formation.

The starfish is preserved as an external mold of the actinal surface in one of the silty sandstone or flagstone layers of the Enfield. It lies on the upper surface of the bed which is characteristically current-rippled, and was evidently carried in and gently laid on the top of the bed in the waning turbulent current phase of the flagstone cycle. Shale, long since weathered away, was probably laid on the abactinal surface. These ripple-marked flagstone layers are usually quite unfossiliferous, and no other fossils were found in the starfish slab or other rocks at the locality. However, other starfish, *Protaster bicatenulata* and *Lepiderasterella gyalum*, have been found in flagstone quarries at nearly the same horizon about a mile away on the south side of the Cascadilla Creek valley.

SYSTEMATIC DESCRIPTION

PTILONASTER PRINCEPS Hall

Plate 24

Ptilonaster princeps HALL, 1868, Twentieth Rept. New York State Cab. Nat. Hist., p. 292, pl. 9, fig. 9. —— SCHUCHERT, 1915, U. S. Nat. Mus. Bull. 88, p. 240. —— RUEDEMANN, 1916, New York S. Mus. Bull. 189, p. 44, pl. 20, fig. 1, text-f. 19, 20. —— SPENCER, 1940, Mon. Brit. Pal. Asterozoa, pt. 10, p. 506, 540, text-f. 331E.

This species, the genotype and only known species, was originally described by James Hall from a fragmentary specimen

[1] The writer is obliged to his friend Porter K. Bennett of Cortland, N. Y., for calling attention to this point.

showing one ray and small distal parts of adjacent rays with intervening parts of the disc.

The holotype is in the American Museum of Natural History (no. 5945, not no. 4472 as listed in Whitfield's catalogue, p. 196) and a cast of this was figured by Ruedemann (1916, pl. 20, fig. 1). An additional figure of details of the ray structure has been published by Spencer (1940, p. 507, text-fig. 331E) based on Ruedemann's cast. Unfortunately the section of Spencer's monograph dealing with this genus and species has not as yet been wholly published.

The new specimen shows the actinal surface of a ten-rayed individual. Ruedemann (1916, p. 45) noted that the sharp angles between the portions of the three rays of the holotype indicated more than the usual five rays. Three rays are complete, the other seven lacking from a few millimeters to two or three centimeters distally. They are 10–13 mm. wide proximally at the mouth frame, tapering gently to their tips. Length of rays: 70 mm. The mouth-frame is oval as preserved, measuring 22×32 mm. Thus the greatest diameter is 17.2 centimeters, a very large size for Devonian starfish. The ray of the holotype measures 70 mm. in length, but is incomplete distally, indicating that even larger sizes were attained. The structure of the wall and floor of the groove of the rays has been studied by Ruedemann and Spencer, and the present specimen confirms their interpretation of the presence of a double series of plates bordering the groove. Each of the outer lateralia bears a single pointed spine. The mouth-frame, which is in closed position, is large and oval in shape, but was probably circular in life. The mouth-angle plates are elongate, narrow, and wedge-shaped, each pair appearing as a pyramidal structure between the inner ends of adjacent rays, each partly overlying the first and second ambulacrals. In the area enclosed by the mouth-frame only the faintest traces can be seen of the spicular disc-skeleton. The interradial skeleton is apparently slightly developed between the rays. Its concave margin extends outwards from about 10 mm. centrally to about 20 mm. along each side of the rays, and it is composed of a meshwork of spicules. Ruedemann mentions a "marginal row of plates" but neither the holotype nor the new specimen shows any trace of such marginalia. The madreporite is on the edge of the interradial skeleton, its external surface directed actinally, and lies between the major and minor axes of the mouth. It is 5 mm. in diameter, hemispherical in shape, with its surface marked by fine, sublabyrinthine ridges and grooves roughly radiating from the center.

Spencer (1940, p. 506) placed *Ptilonaster princeps* in his Group K, a group of primitive ophiuroids marked by the double series of plates bordering the groove. The other genera of the group, *Phragmactis*, *Sturtzaster*, *Bdellacoma*, and *Rhopalocoma*, are all five-rayed forms, and except for the arrangement of the ray plates, none of them resembles *Ptilonaster*, as now revealed by the new specimen, at all closely. Ruedemann (1916, p. 46) suggested that *Ptilonaster* might prove "with better material to have been a large *Lepidasterella* or *Helianthaster*, both multirayed Devonian starfish resembling *Ptilonaster*, a relationship not borne out by the Enfield specimen. The marginal position of the madreporite and the absence of marginalia suggest that what appears to be an interradial skeleton is not the interradial skeleton of typical ophiuroid build, but the result of compression of a domed apical skeleton (vide Spencer, 1940, p. 510, text-fig. 333), and that the madreporite was apical and marginal as in *Sturtzaster*.

Occurrence.—Upper Devonian (Senecan series, Finger Lakes stage): Ithaca formation, vicinity of Cortland, N. Y. (holotype, AMNH 5945); Enfield formation, Casca-

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EXPLANATION OF PLATE 24 (FACING PAGE 119)

Ptilonaster princeps Hall. Natural mold of actinal surface of nearly complete individual, ×1, in flagstone from middle Enfield formation (Upper Devonian), south side of Mt. Pleasant, Cascadilla Creek valley, Tompkins Co., N. Y. (Cornell Univ. Paleont. Coll. No. 39057). M = madreporite (also shown at upper right, ×5); A = part of apical skeleton.

(*Note:* cost of plate defrayed by Gurley Fund, Dept. of Geology, Cornell Univ.)

dilla Creek valley near Mount Pleasant, Tompkins County, N. Y. (Cornell Univ. Paleont. Coll. No. 39057).

REFERENCES

BARTRAM, JOHN, 1751, Observations . . . on his travels from Pensilvania to Onondago, Oswego . . . London.

HALL, JAMES, 1868, Note on the genus *Palaeaster* . . . : 20th Ann. Rept. Regents Univ. N. Y., New York. State Cab. Nat. Hist., p. 282–303, pl. 9.

RUEDEMANN, R., 1916, Account of some new or little-known species of fossils: New York State Mus. Bull. 189, p. 7–97, pls. 1–31, 32 text-figs.

SCHUCHERT, C., 1915, Revision of Paleozoic Stelleroidea with special reference to North American Asteroidea: U. S. Nat. Mus. Bull. 88, 311 p., 37 pls., 41 text-figs.

SPENCER, W. K., 1940, A monograph of the British Palaeozoic Asterozoa. Palaeontographical Society, pt. x, p. 495–540, pls. 33–37, text-figs. 322–348.

WHITFIELD, R. P., 1900, Catalogue of the types and figured specimens . . . Pt. 3. Amer. Mus. Natural History, Bull., vol. 11.

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JOURNAL OF PALEONTOLOGY, VOL. 26, NO. 1, P. 123, JANUARY 1952

PALEONTOLOGICAL TECHNIQUES

DEVELOPMENTS IN MICROPALEONTOLOGICAL TECHNIQUE

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As a result of research on smaller Paleozoic Foraminifera, begun at the University of Glasgow and continued in the Department of Geology, Birkbeck College, further developments of technique have been evolved which may be of interest to other workers.

Wood (1945) described a rapid method of making accurate drawings of small microscopic objects using a camera-bellows and tracing paper. In order to increase the speed of copying, where large numbers of drawings are required, the original method of Professor Wood has been further developed.

A simple type of microprojector, consisting of a microscope and a peephole camera, has been constructed and used to record foraminiferal sections in rock slides and progressive orientated sections through individual specimens. With either transmitted or reflected light an image is focused on a ground glass screen and the latter replaced by an adapted plate holder containing sheets of ordinary contact printing paper, usually a bromide paper. Exposure and developing produce "trace" photographs.

By this method as many as 60 enlarged accurate "trace" photographs of small microscopic objects can be produced in one hour. Magnifications up to ×250 can be obtained without any marked loss of detail, and costs are kept at a minimum by using printing paper and not making true negatives. Objections may be raised on the grounds that these "trace" photographs are merely paper negatives and hence reveal the converse of true shade patterns, but this method is intended solely for routine work and the results are not meant for final presentation. The contrast and intensity which can be achieved goes far beyond those of line drawings. Detailed records of the wall structure of endothyrids have been made at magnifications exceeding ×200.

The value of plastic resins as mounting media in the accurately orientated thin sectioning of microfossils has been noted previously by the author (1950). This technique has been advanced further in order to achieve serial sectioning through individual Foraminifera.

After mounting and orientation the specimen is ground to the plane of the required initial section. The surface is etched slightly, using a camel hair brush and dilute hydrochloric acid. A cellulose peel is then taken of this surface by the normal methods (e.g., Dollar, 1942). Using micrometer readings and continued grinding and preparation of peels it is possible to build up a three-dimensional picture of the interior of the foraminifer.

This serial sectioning of microfossils requires great care and much practice before complete success can be assured. Difficulties may arise from excessive or insufficient etching and from incorrect viscosity in the cellulose fluid. For these reasons the materials and times of application should be determined from a study of spare material before the actual research task is begun.

REFERENCES

CUMMINGS, R. H., 1950, Oriented thin-sectioning of microfossils: Cushman Found. Foram. Research Contr., vol. 1, pts. 3, 4, pp. 66–67.

DOLLAR, A. T. J., 1942, Laminar moulds in cellulose acetate for the study of rock and mineral structures: Geol. Mag., vol. 79, pp. 253–255.

WOOD, A., 1945, A rapid method of making accurate drawings of small microscopic objects: Geologists' Assoc. London Proc., vol. 56, pt. 1, pp. 18–19.

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NOMENCLATURAL NOTE

HESPEROCYON SCOTT 1890 FOR *PSEUDOCYNODICTIS* SCHLOSSER 1902

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The small dog from the White River Oligocene deposits known as *Pseudocynodictis* has had a long confusing terminology. Joseph Leidy (1856) first described the species as *Amphicyon? gracilis*. This name was preoccupied by *A. gracilis* Pomel 1853.

The changes in generic terminology are given below in chronologic order.

1856. J. LEIDY. *Amphicyon? gracilis*. Notice of remains of extinct Mammalia, discovered by F. V. Hayden in Nebraska Territory. Proc. Acad. Nat. Sci. Phila., vol. 8, 88–90. (Name preoccupied by *Amphicyon gracilis* Pomel 1853.)

1871. O. C. MARSH. *Amphicyon angustidens*. Notice of some new fossil mammals and birds from the Tertiary formations of the West. Amer. Jour. Sci., (3) vol. 2, 120–127. (A related [or the same?] species.)

1873. E. D. COPE. *Canis gregarius*. Third notice of extinct Vertebrata from the Tertiary of the Plains. Pal. Bull., no. 16, 1–8. (Cope apparently knew that Leidy's name, *gracilis*, was preoccupied. He applied a new specific name, *gregarius*, referring the species to *Canis*.)

1881. E. D. COPE. *Galecynus gregarius*. On the Nimravidae and Canidae of the Miocene period. Bull. U. S. Geol. Geog. Surv. Terr., vol. 6, 165–181. (Referred the species to *Galecynus* Owen 1847.)

1890. W. B. SCOTT. *Hesperocyon*. The dogs of the American Miocene. Princeton Coll. Bull., vol. 2, no. 2, 37–39. (Scott proposed the name *Hesperocyon* for, "The second canine genus of the White River . . . .)

1898. W. B. SCOTT. *Cynodictis*. Notes on the Canidae of the White River Oligocene. Trans. Amer. Philos. Soc., vol. 19, 32–415. (It is interesting to note that Scott either overlooked or rejected the name he had given referring the species to *Cynodictis* Bravard and Pomel 1850.)

1902. M. SCHLOSSER. *Pseudocynodictis*. Beiträge zur Kentniss der Säugethierreste aus den Süddeutschen Bohnerzen. Geol. Pal. Abh., vol. 5, no. 3, 117–258. (Schlosser pointed out a number of generic differences between the European *Cynodictis* and the American species, applying the name *Pseudocynodictis* to the latter.)

1936. W. B. SCOTT and G. L. JEPSEN. *Pseudocynodictis*. The Mammalian fauna of the White River Oligocene. Part I. Insectivora and Carnivora. Trans. Amer. Philos. Soc., (n.s.) vol. 28, 1–153. (Not until 1936 did Schlosser's name become generally accepted with its adoption by Scott and Jepsen.)

Hesperocyon Scott has definite priority over *Pseudocynodictis* Schlosser by 12 years. The latter name has not been established in the literature long enough to warrant any excuse for not applying the Law of Priority.

By reviving the name, *Hesperocyon*, we not only are able to place the awkward *Pseudocynodictis* in synonomy but pay a tribute to the late William Berryman Scott for his early studies on the extinct Canidae.

NOTICE

A considerable number of copies of volume 1, no. 1, of the Contributions to American Paleontology (1886), containing "Descriptions of New Silurian and Devonian Fossils" by E. O. Ulrich, is still available at The American Museum of Natural History, New York 24, New York. (See *Journal Paleontology*, vol. 21, 1947, p. 500.) Copies may be obtained free upon request, to be addressed by Dr. Otto H. Haas.

The committee on the Illustrated Catalogue of North American Devonian Fossils announce the publication of Unit 1-F, part a, covering the tetracoral families Hadrophyllidae, Syringaxonidae, Acrophyllidae and Halliidae. The 88 cards of this unit (prepared by Dr. E. C. Stumm), together with almost all of the earlier units of the catalogue, may be obtained from Wagner Free Institute of Science, Philadelphia 21, Pa.

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NOMINATIONS FOR OFFICES IN THE PALEONTOLOGICAL SOCIETY FOR 1952–1953

In accordance with the provisions of Chapter III, Section 2 of the By-Laws, the Council of the Paleontological Society announces the following nominations for offices in the Society for 1952–53:

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Chapter III, Section 2 of the By-Laws provides that "Any twenty members may forward to the Secretary other nominations for any or all offices. All such nominations reaching the Secretary at least sixty days before the Annual Meeting shall be printed, together with the names of the nominators, as special tickets."

NOMINATIONS FOR MEMBERSHIP

In accordance with Article 3, Chapter 1 of the By-Laws of the Paleontological Society, the Secretary submits the following applications for membership in the Society. They have Council approval.

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NOTICE

ANNUAL MEETING S.E.P.M.
Biltmore Hotel, Los Angeles
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The annual meeting of the S.E.P.M. will be held at the Bitmore Hotel, Los Angeles, California, on March 24, 25, 26, and 27, 1952. As in previous years the meeting will be held jointly with the A.A.P.G. and S.E.G.

In addition to presidential addresses and joint sessions with the other two societies, there will be separate technical sessions, symposia, and a field trip. The annual S.E.P.M. symposium will be on "Objectives in Modern Sedimentology and Paleontology." There will probably be another one on "Recent Marine Sedimentation." The field trip will be to type localities of several well-known formations which have excellent micro-faunas.

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